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THE WORLD IS ITS FIELD

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THE TRADE OF THE AMAZON, AND THE PORT OF PARÁ.

By David F. St. Clair.

Glowing expectations are entertained for American commerce with the West Coast of South America, following the opening of the Panama Canal. It may be well, therefore, to consider whether the United States realizes its commercial opportunities on the already accessible East Coast. Mr. St. Clair's article indicates what some of these opportunities are. —THE EDITORS.

NORTHERN Brazil has three unique possessions—a practical monopoly of the crude rubber of commerce, the world's greatest river valley, and the city of Pará. The reader may wonder why the city of Pará, a city of only 200,000 inhabitants, resembling all other progressive Latin-American cities, should be included with the other two. Because Pará embraces the other two; yes, commands the other two. Pará fixes the price of nearly $100,000,000 worth of crude rubber, nearly half of which was last year consumed in the United States. Pará is without a possible rival or neighbor on a coast of nearly a thousand miles. Pará sits at the only navigable mouth of the great Amazon. Pará is three thousand miles from New York, three thousand miles from Buenos Aires, nearly three thousand miles from Iquitos, Peru, near the head of steamboat navigation on the upper Amazon. Pará is three thousand miles from Lisbon, and it is four thousand miles from London. Pará is not only the sole gateway of all northern Brazil, but of all trans-Andean Colombia, Peru, Equador, and Bolivia. More to the Southern Continent is it to become than New Orleans can ever be to the United States. Pará is one of the unique geographical and commercial centres on the globe.

Nature seems to have given Pará almost everything but a modern deep seaport. The city is located on the Pará River, an estuary of

GENERAL VIEW OF THE CITY AND PORT OF PARÁ.

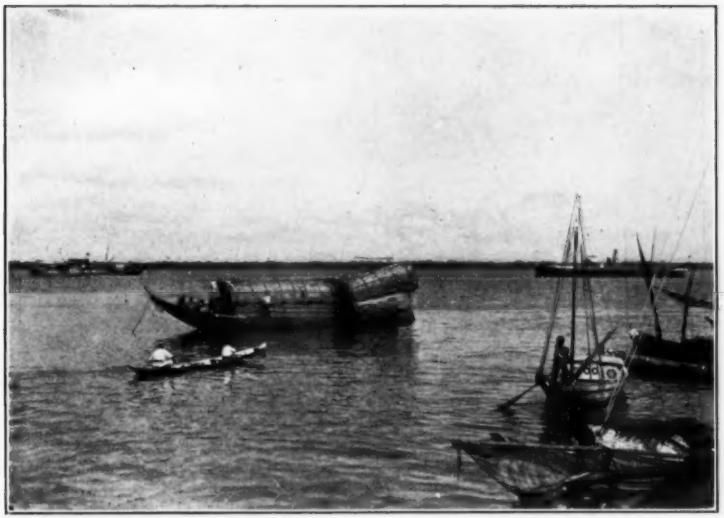
the Amazon, and is sixty-five miles from the open sea, but the deep water of the sea comes up to within three or four miles of the city. Above the city and between the main stream of the Amazon the river is deep enough for the navigation of large ocean-going steamers. The main mouth of the Amazon is not navigable on account of shifting sand bars and a tremendous bore; therefore, the port of Pará is the sole feasible port of the Amazon mouth. But at mean low tide the present depth of the water at the quay walls in front of the city is only 19.7 feet. Because of this fact the growing shipping of Pará has had to be carried on by an expensive system of lighterage, or else freight had to be transferred from river steamers to ocean steamers under the difficulties of wind and tide.

Notwithstanding this handicap, the value of imports from foreign countries grew between the years 1902 and 1907 from $9,000,000 to $21,000,000, and the exports to foreign countries from $15,000,000 to $25,000,000. The custom-house receipts increased from $3,600,000 to $12,000,000.

In 1867, when Pará was hardly more than a small trading post, the then imperial government of Brazil planned to have its harbors and ports constructed by private companies with their own capital, receiving a certain per cent of the custom-house receipts over a number of years as compensation. Pará was included in this policy. In 1876 the Emperor Dom Pedro

made a visit to the United States and Europe with a view of finding contractors and engineers who would undertake this work. He saw James B. Eads, who was opening the mouth of the Mississippi, and there he met in charge of the work a young hydraulic engineer of genius, Elmer Lawrence Corthell.

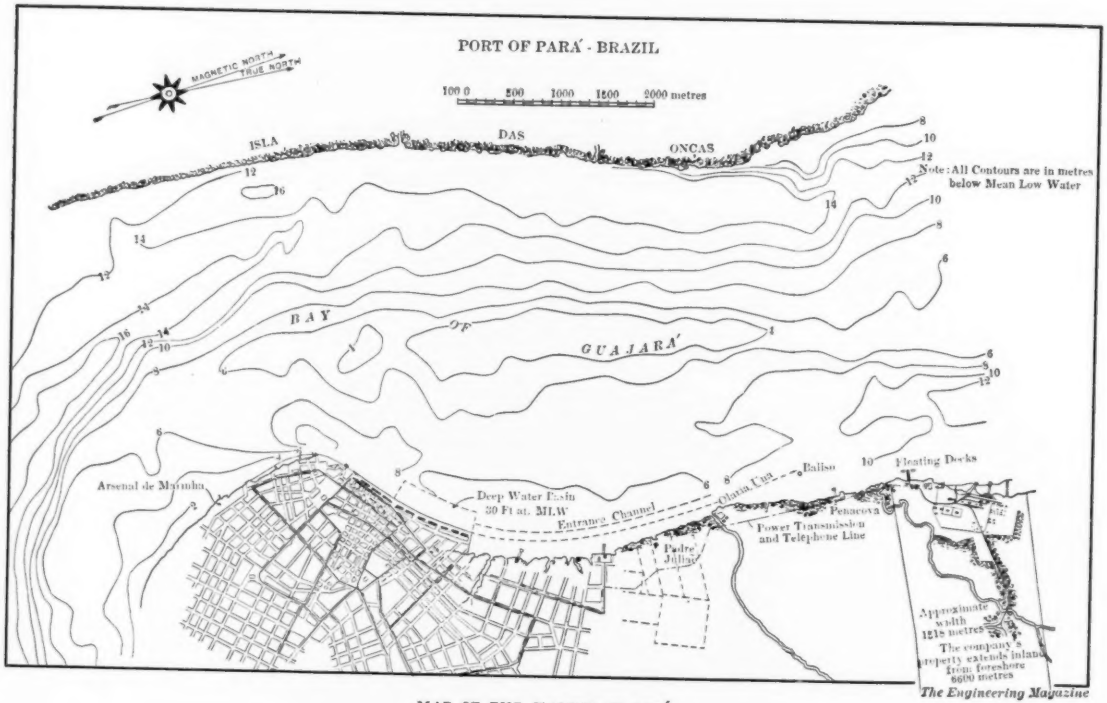
"I have found the engineer!" exclaimed the Emperor; but in those days capital was not attracted to South America. The republican government was, however, wise enough to continue this imperial policy, which has served to open three or four of the most important ports of the republic.



NATIVE CRAFT TRANSPORTING RAW RUBBER DOWN THE PARÁ RIVER.

Pará, although now ranking as the third port among Brazil's twenty-one important seaports, had to wait. It was distant from the federal capital and might have had to wait even longer but for the world's commercial hunger for india rubber. Because of the variety of its uses and its great necessity, rubber is a more useful product than cotton.

Some six years ago the world had a vivid illustration of the commercial importance of rubber. A war was threatened for several weeks between Brazil and Bolivia over the boundary of the territory of Acre. Rubber was at the bottom of it, and this scare flashed a lime-light upon Pará and the Amazon Valley. It awoke not only

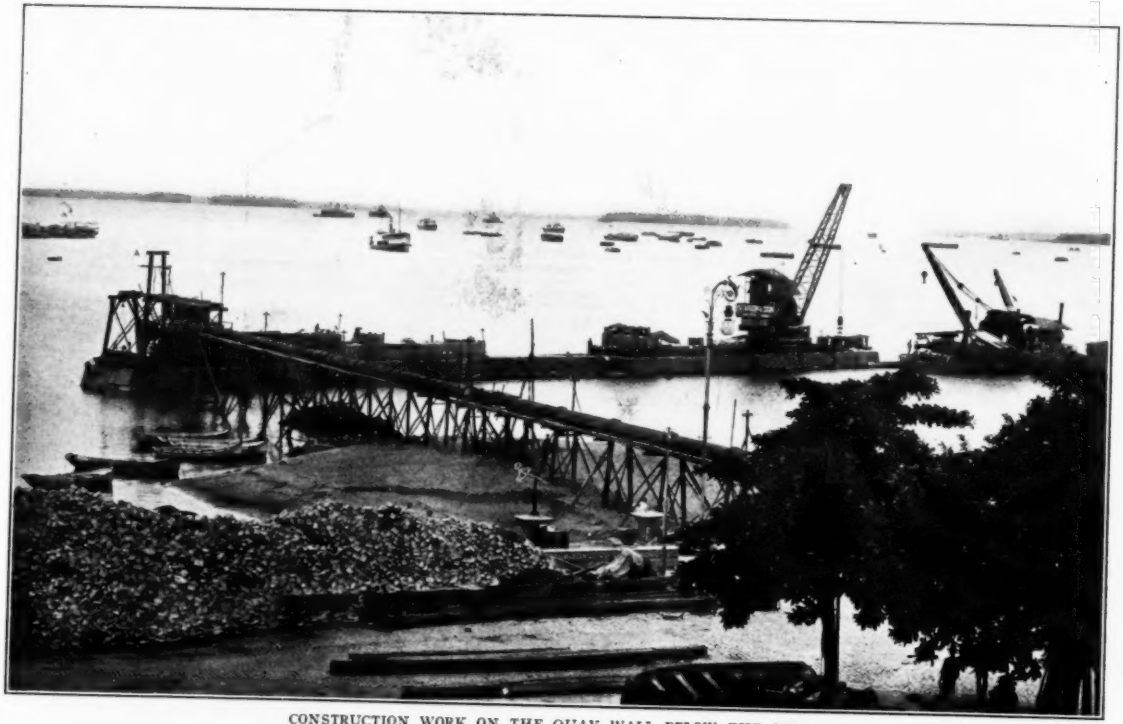


MAP OF THE HARBOR OF PARÁ.

A RIVER STEAMER IN DRY DOCK.

Brazil and Bolivia, but all those rich countries contiguous to the Amazon Valley. It did more. It aroused the public spirit of the city of Pará and caused its great rubber exporters to move with the power of an avalanche for a modern port. Many years previous, a municipal commission had made a survey of the port and charted it with its river currents and tides.

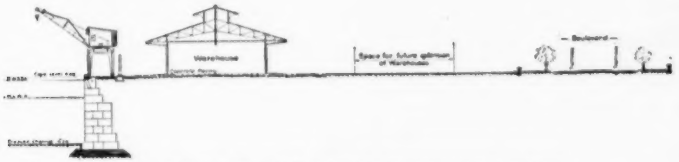
With this survey as a basis, the federal government finally approached an American corporation building tramways and railroads in Brazil. This corporation is headed by Perceval Farquhar, a native of York, Pa., who is reported to have invested $150,000,000 in the



CONSTRUCTION WORK ON THE QUAY WALL BELOW THE CITY.

industrial and commercial development of the republic. This company sent Mr. Corthell to make a detailed study of the port of Pará and its commercial possibilities. It was on his report that the federal government entered upon a contract with the American company organized as the Port of Pará Company to construct the port of Pará as well as the port of Rio Grande do Sul in the south of Brazil.

More than a year ago the active work of construction of the port was begun and is now in full progress. The chief engineer of the work is L. Quellenec, chief engineer Ponts et Chaussées of France, and consulting engineer of the Suez Canal. Mr. Corthell is the consulting engineer. The contractors for the substructure dredging and filling are S. Pearson & Son, Limited, of London, and for the superstructure and facilities for operating the port are Schneider & Cie (Le Creusot) of Paris.

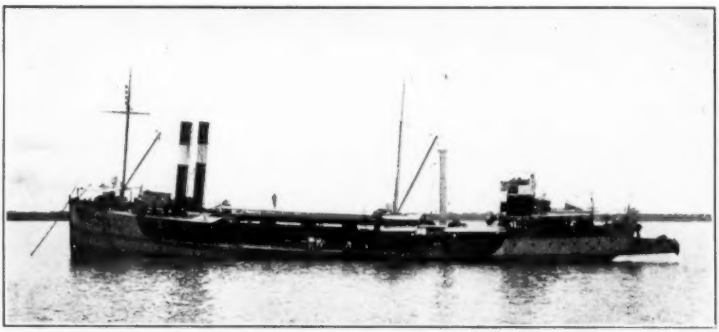


CROSS SECTION OF PARÁ HARBOR-IMPROVEMENT WORKS.

The location of the port and the method of construction have been changed in some respects on account of the discovery of deep mud at some places on the original location. It was necessary to move the line towards the shore to get on to hard clay and avoid the use of pile foundation for the quay wall.

The general plan of construction calls for a quay wall 3,280 feet long, with a depth of water in front of 30½ feet; also a quay wall 1,640 feet long, with a depth of 10 feet in front (the former for deep-sea ships and the latter for Amazon River boats), and 3,875 feet of shallow wall, partly for small boats and partly to improve the city front. The general process of construction is as follows:—

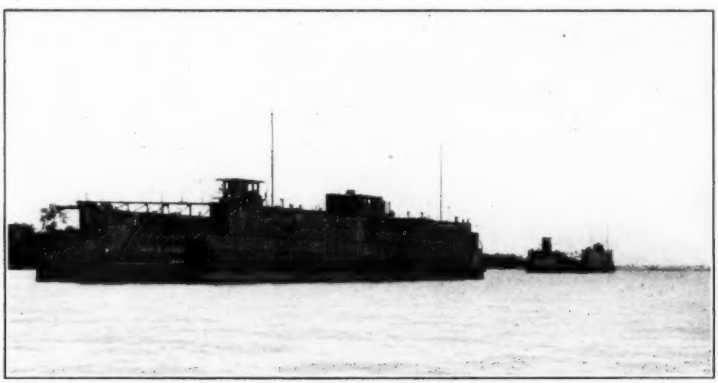
A trench is dredged (by bucket dredger) in the hard clay to receive the riprap stone for the foundation, about a meter in thickness. Divers level off this stone. Railroad rails are then laid on each side of the trench on the riprap at the proposed elevation of the upper surface of the stone. Other rails are moved along these rails lengthwise of the wall, and the stone is brought to the under side of the rails or moving templates across the entire width of the base of the wall. Blocks are then brought forward by the Goliath and by the help of divers are placed in proper position on the riprap foundation. A



THE SUCTION DREDGE MIGUEL CALMON.

"topping crane" follows and brings the wall up to the coping level. The space between the quay wall and the shore will be filled in with sand dredged by suction from a shoal in front of the port and warehouses and railroad tracks built thereon. Spacious fireproof warehouses are to occupy the entire length of the port.

The government guarantees the Port of Pará Company 6 per cent interest on the capital invested from the beginning of actual construction, and afterwards, when the port is in operation, during the entire term of the concession, which runs to 1973 and to 1996, if the second division of the port shall be built. At those dates the entire property reverts to the government, capital employed having been amortised by a sinking fund provided for in the concession. But the government can purchase the property any time after January 1, 1923, by paying an amount that will produce 8 per cent per annum on

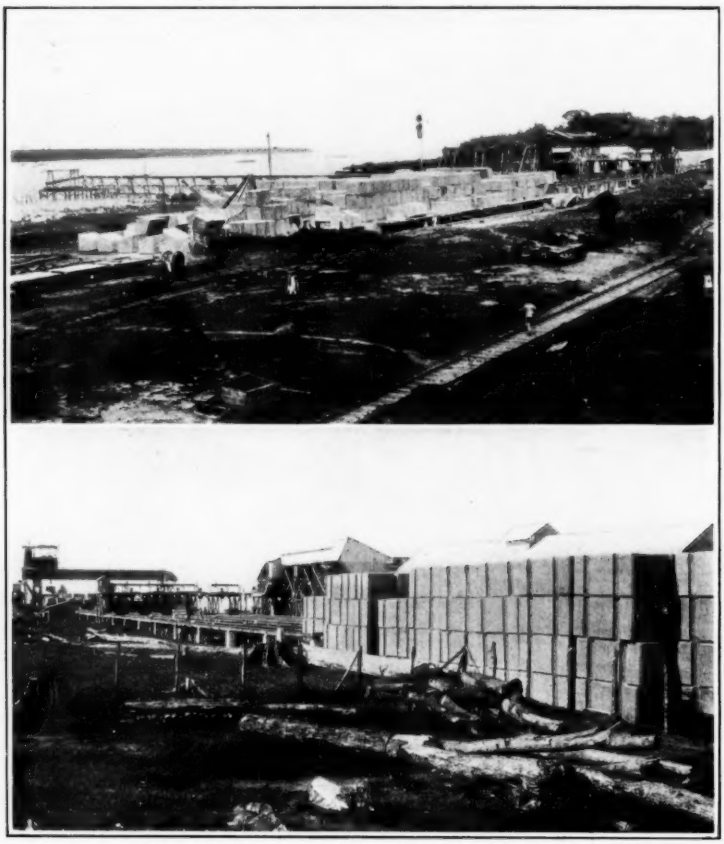


THE FLOATING DRY DOCKS IN THE HARBOR AT PARÁ.

TWO VIEWS OF THE QUAY WALL UNDER CONSTRUCTION, SHOWING THE CRANE LIFTING AND PLACING THE CONCRETE BLOCKS.

the capital in the works up to the time of purchase. A 2 per cent gold tax on all imports is collected to guarantee the interest; 35 per cent of the gross revenues are reserved for expenses of operation of the port. The company will take over the port and operate it after 100 meters of the quay wall have been finished, which will be about November 1, 1909. When the works are finished Mr. Corthell declares the port will be equal in point of facilities with any port of the world.

Some of the illustrations show the company's works at Val de Caens, four miles down the river, where a number of steel docks for steamboat repairs have been constructed. Val de Caens was purchased by the company and is located at the second division of the



CEMENT MIXERS AND BLOCK YARD AT VAL DE CAENS.

VAL DE CAENS, AS SEEN FROM THE LAND SIDE.

works, work on which, it is estimated, the increased commerce of the port will soon demand.

The Port of Pará Company is also constructing the Madeira-Mamoré railway, 260 miles long, flanking the falls on the Madeira river (one of the chief tributaries of the Amazon), which has its source in the Bolivian Andes, 3,500 miles from Pará. This river is navigable to its headwaters, which are being joined by railroad from La Paz, the capital of Bolivia, nearly 4,000 miles from Pará. By the treaty between Bolivia and Brazil in which Acre with its rich rubber forests was ceded to the latter for $2,000,000, Brazil bound itself to give to Bolivia every commercial facility of the Amazon and the port of Pará.

Bolivia east of the Andes is one of the richest regions of the world in timber, rubber, and minerals, and it has some fine agricultural lands. It has no outlet on the Pacific coast. Its only outlet is through the Amazon and Pará, and since peace was made with Brazil a railroad activity in this direction has taken possession of the whole republic. East of Bolivia is the great Brazilian State of Malto Grosso, a territory nearly three times the size of Texas. A dozen large navigable rivers pour northeastward out of this State into the Amazon. Its agricultural, mining and grazing possibilities are very great. It is said that a great deal of this territory will grow as fine long-staple

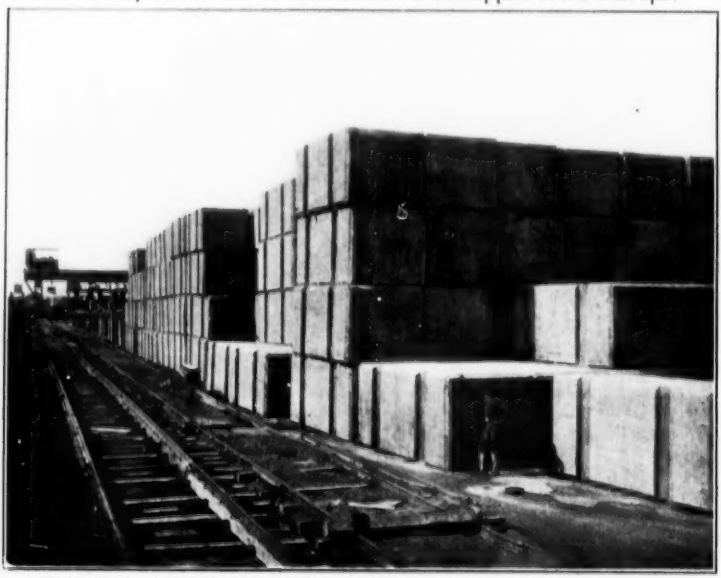
A SHOP AT VAL DE CAENS.

cotton as Mississippi or Alabama. The Brazilian Government has matured a plan to connect by canal one of the tributaries of the Amazon with one of the tributaries of the La Plata in this State, thus opening an all-inland water route from Pará to Buenos Aires, a distance of nearly 5,000 miles. This extensive route would reach the whole interior of the continent.

Turning to the west and northwest, the Amazon is navigable in its chief tributaries in Peru, Equador, and Colombia to the very walls of the Andes. One may go aboard a steamer at Pará and remain aboard until it has ploughed its way up to the hill city of Iquitos and several hundred miles beyond. Peru has little Pacific coast trade now and the development of this country must pour its wealth into Pará. But if Brazil and Pará had none of these Andean republics to draw trade from, the development of the Brazilian Amazon Valley alone must in time amount to untold wealth. In the States of Pará and the Amazonas and the federal territory of Acre there are near the water's edge ten million rubber-bearing trees of the Hevea variety. These trees if properly tapped will live indefinitely and steadily increase their yield. The State of Pará is considerably larger than Texas, and much of this State will grow excellent cotton. North of the Amazon it has vast fertile table lands possessing a fine climate, suited to the white man under the equator.

THE FLOATING DRY DOCK IN SERVICE.
Above, a tug and hopper barge are docked. Below, it is rising with a river steamer.

It has been estimated that the Amazon and its tributaries possess 40,000 miles of navigable water. This great valley comprises 2,722,000 square miles; the Mississippi Valley comprises only 1,253,000. The Madeira river is itself a second Mississippi in its volume of water, and the Amazon for nearly 2,000 miles maintains a depth of 60 to 200 feet. It is truly an inland sea 40 miles wide at many points. There ply on it more than 100 large river steamers between Pará and Manaos, the latter city 1,000 miles up the river; and the smaller steamers and craft of all descriptions afloat on this vast river system are almost numberless. Seven ocean lines of steamers enter the port of Pará, six to Europe and one to New York. Much of the raw rubber that Pará exports to the United States is reshipped from Europe.



CONCRETE BLOCKS AT VAL DE CAENS, READY FOR SHIPMENT TO THE QUAY WALL AT PARÁ.

The business men of Pará are awake to the fact that if the city is ever to enjoy the full fruits of a monopoly of rubber it must vulcanize and manufacture goods of the great bulk of the raw rubber that it now exports. At the instance of these business men a bill has been introduced in the Brazilian Congress to exempt from taxation rubber factories. Although rubber goods, like cotton goods, are the products of the highly civilized centres of the world, yet Pará, even though a few miles south of the equator, aspires to become one of these centres, and the city possesses many of the needed elements.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

I. THE DEFINITION OF FACTORS OTHER THAN LABOUR.

Mr. Church's study of the distribution of expense burden, which appeared first serially in this Magazine and since has been issued in book form, is widely known as one of the very important contributions to exact knowledge of costs of production. In the series here begun he extends the idea much farther, and proposes a new way of looking at the whole problem of manufacturing expense. His purpose is to avoid the averagings and approximations of a mixed expense account, now commonly in use, by recognizing, from the very beginning all the important factors in production, and segregating from the outset those things belonging to each. His development of the idea and the process will be followed with interest by all who are associated with the investigation of the real facts of production costs.—THE EDITORS.

THE method of organisation by production factors is not so much an addition to the innumerable varieties of cut and dried "systems" as a new way of looking at the facts of production.

From the earliest days of manufacturing there has grown up a custom of considering labour as the main and only direct item in production, and of expressing all other expenditure in more or less vague percentages of wage cost. The fact is, however, that labour, while always important, tends to become less important relatively to other items as the progress of organised manufacture develops and the use of specialised and expensive mechanical equipment increases. Very few concerns have come to grief by ignoring labor costs, but many have passed into the hands of receivers by ignoring the relative importance of the other factors of production.

It is time, therefore, to see whether some fundamental change in the point of view commonly taken of production is not both possible and desirable—whether the older point of view, in which a large number of heterogeneous activities are grouped round the central idea of wage-labour, is not capable of replacement by a newer one, in which the greatest possible number of separate factors are recognized, kept distinctly and separately in view, and the bearing of each on cost of production treated individually. It cannot be denied that this is a decided wrench from ordinary custom and routine, and that to many it will seem unnecessary. Its chief merit, however, may be considered as tending both to greater accuracy and a nearer approach to the recognition of actual facts. Once the prepossessions due to the

older method are removed, it will also be seen to have the character of greater simplicity, both in the way in which it enables the facts of production to be grasped and in the working up of data into the form of costs.

It is preferable to consider this as a matter of organisation and not merely as a matter of costs. The great value of accurate cost accounts lies in the way in which they represent the results of organisation—summarizing a multitude of facts far too numerous and complex ever to be ascertained without very careful record. But the best system of costs cannot do more than give results severely conditioned by the form of the organisation. No existing system of costs is worth anything by itself; the data it provides must be read in connection with a knowledge of the form of the organisation—except, of course, when "prime" or "flat" costs alone are being considered. The proof of this statement will be recognised when it is considered that no two costs from different works can be compared, unless the method on which the indirect charges are estimated is identical in both works—a consideration that shows how very artificial and arbitrary much of even the most highly organised cost accounting really is.

This artificial and arbitrary character is inseparable from existing methods, because these latter do not attempt to disentangle the facts of production (except wages costs) but run them all together, with the result that they appear as a blurred or confused picture without any significance—without, indeed, any real meaning. So much is this the case that great difference of opinion exists as to the way in which indirect charges should be treated, a very common idea being that their percentage to wages should be artificially maintained as steady as possible; and all sorts of averaging methods, "suspense accounts" and the like, are made use of to keep these percentages from fluctuating. Yet it is just as irrational to reduce many of the factors of production to an "average" as it would be to throw all wages into a common account and spread them over work on a similar averaging plan.

It has been said that the best system of costs needs to be read with a knowledge of the organisation—whenever we try to go beyond flat costs. It is probably the practical realisation of this that has made many employers doubt the value of highly organised systems and content themselves with very elementary information as to bare wages and material costs. With something certain to go upon, they argue, practical intuition will do the rest. Elaborate methods of connecting charges with costs, being for the most part based on

averages, throw no light on individual jobs, and for all practical purposes such charges can be ascertained roughly and broadly at infrequent intervals, kept in the head, and mentally added to the prime or flat cost of a job at any time when the latter is under discussion. It must be admitted that there is a good deal of justification for this point of view.

The truth is that a more extraordinary jumble of figures that have no connection with each other, and no significance in relation to any particular job, cannot be found than the so-called expense accounts of most manufacturing businesses. Very few persons, even of those who use them daily, realise what they mean practically. No one, commonly, has the least idea how they are likely to be affected by an expansion or shrinkage in the volume of work, and if so affected, what deductions can be safely made from their rise or fall. Yet, unless their existence is a real benefit and has a real significance, their collection and working up is a wholly idle expense. The heterogeneous items of expense accounts have no relation to each other, any more than they have, directly, to labor itself. The most cunning and involved system in the world cannot make them have any relation to each other or to labour. Any attempt to do so, and to express them in the form of percentages on labour, really "darkens counsel" and performs the very dangerous service of representing something to be a useful fact which hardly attains to the dignity of a fact at all.

But though these heterogeneous items of expense have no relation to each other or to labour, many—in fact, most of them—have a very real and intimate relation to production, and to cost of production. Instead, therefore, of laboriously collecting them together and trying to fit them by main force into some artificial relation to labour, it may lead to altogether new results if we keep them separate—if we cease to jumble together the cost of coal, the depreciation of machinery, and the rent of land or buildings, calling the aggregate total "expense," but rather take the point of view that each of these diverse items of expenditure has its own special influence and its own true incidence on the cost of production, and see whether any practicable method suggests itself of representing that special influence in the system of registering representative facts that is called "costs."

What Is a Production Factor?

A Production Factor may be defined as any expense that has a *definite* relation to cost of production. It is not pretended that all and every item of expense can be reduced to production factors, but it will be seen that a very large and important number of them can be so reduced. The principle of "Organisation by Production Fac-

tors" is to keep things in sight that are generally covered up, disguised and lost to view, and to observe the facts and phenomena of production along natural lines, as distinct from arbitrary and artificial lines.

Hitherto the only recognised production factor has been labour, as expressed in wages costs. (To simplify the argument all consideration of material is omitted—it does not affect the question of process work at all, and our discussion is confined to this for the present.) Between the cost of a piece of work and the wages paid for the operations performed upon it the closest connection has always been realised. In certain kinds of work, as, for example, a man performing a repair job on some one else's premises and with his own tools, labour is the *only* factor of production.* But in proportion as labour finds itself situated in the midst of a highly organised modern works, so it ceases to be the only factor of production, and in the extreme case of a roomful of nearly automatic machinery, may cease even to be an important factor.

In the case of the highly organised modern works, what are the other factors of production? When we have ascertained this and have placed and enumerated them, it will be seen that the other factors are just as definite in their incidence on work, and just as important to keep in close scrutiny, as labour itself. We shall see also that this organisation by production factors has important indirect benefits in matters of comparison, of control, and of maintaining a high pitch of efficiency.

The mind readily grasps the idea that when a man is at work machining a large casting, the man's wages are, so to speak, passing into that casting and being absorbed therein. It is readily seen that this is a case of "productive" expense—the work of the man is actually going towards making the thing worked on more valuable. This picture is so familiar and is so easily understood that it seems to be like no other element of production. Labour, in short, seems to be *the* production factor.

Actually, however, as is implied in all systems of "distributing" indirect charges, much more than labour-cost is passing into the casting. The wear and tear of the machine tool, every stroke or revolution of which is shortening its life and rendering it necessary to replace it one day, is also passing into the casting. The interest on the value of the machine tool, the cost of the power that drives it, and

* Even here a rigidly careful analysis may detect other factors—as, from the workman's point of view, the supply and repair of his tools, risk of the work, risk of idleness between jobs; from the employers', interference with other use of the premises, time and cost of securing the workman, of inspection, etc.—Ed. E. M.

the cost of keeping it in repair from day to day, are also items which are passing into the cost of machining the casting. That this is so will generally be admitted, yet the picture is not so definite as in the case of labour. The wages of the man are taken out of the cash box, whereas the cost of the other items cannot be pictured in anything like such a definite way. Further, there is a difference between labour and many other items of productive expenditure. The cost of labour can be shut off suddenly and completely. Most of the other items are not so terminable. Their cost must be met whether work is being done or not. It is perhaps this difference in permanence that has been the determining feature in placing labour in one class and all other expenditure in another and less distinct class. When it is admitted that labour is, also, by far the largest *single* class of expenditure, the reason why it has eclipsed and obscured all the other items may be understood.

The fact that one item of expenditure, and that often the largest, can be cut off when it is no longer needed, and that other items are either quite permanent (as in the case of rent) or merely diminishable (as in the case of power) is not, however, of the fundamental importance that it seems. It is a distinction, but a distinction neither of great interest nor of great significance. In ordinary expense treatment, where no provision is made for taking up the heavier incidence due to slack production, the averaging method appears to meet the circumstances—but it does so merely by slurring over differences which should be brought to light, and by losing sight of realities which should be kept steadily in view. When we come to consider the very varied functions that costs discharge, we shall see that the averaging method produces a comfortable uniformity at the sacrifice not only of accuracy but of a great deal of useful information. It may simplify the argument at this stage, however, if we confine our attention to the case of a concern working full time, leaving till later the problem of slack production.

When working full time the suggested difference between labour and other expenditure in respect of permanence disappears. The cost of work is then made up of various factors—all of them functions of time—labour being the largest single item in most cases, and the others perfectly independent not only of labour but of each other. Under these conditions our conception of labour as the main direct factor in production becomes usefully expanded, and the term "production factor" is made to include many other distinguishable expenses, all of which are now jumbled together in the general term "indirect expense."

Analysis of the Activities of Production.

Much of the confusion surrounding the subject of expense has arisen from the fact that in most cases the manufacturer does other things than manufacture. He fulfils other functions, and though these functions are undertaken by him only with a view to the main object—viz., to manufacture—yet they are in their nature clear and distinct from manufacturing. No object is gained, but on the other hand many disadvantages are suffered, by mingling and confusing these other functions with the manufacturing organisation pure and simple. Looking at the question from the point of view of costs, not only is no object gained, but an entirely false view is very often given of the whole position, leading to financial misconceptions that are always perilous and may easily be disastrous.

In a series of articles by the present writer, published some years ago in The Engineering Magazine and recently issued in book form,* it was pointed out that the "analysis" of expense burden or indirect charges into classes of expenditure was, in fact, an inversion of the natural process. Things which have no natural relation to each other should not require analysis; they should never be mingled at all. The point of view then presented has been widely admitted to be the correct one, and it is the object of the present series of articles to carry the process a stage further and to show not only that the incidence of expense burden *can* be connected with actual jobs, but to demonstrate that most of the component items are perfectly legitimate and separate charges for "services" rendered to production, just as labour is a "service" rendered to production. The arguments offered in the earlier series of articles are not affected by this expansion of the point of view. They are, in fact, reinforced by a clear recognition of the underlying principles of productive activity.

Hitherto it has been customary to regard the questions of organisation, and therefore of costs, from the point of view of an enterprise in full swing. It has been usual to enter, figuratively speaking, a works or factory, to contemplate the varied activities going on therein, and to try to "analyse" these activities into groups, so that some guide to the maze may result. This, it may be said, is the natural method of the accountant, but it should not be the method of the organiser. Where a large number of facts have to be co-ordinated, many of them are likely to be roughly and forcibly fitted into groupings to which they scarcely belong. That this is what actually happens may be shown by comparing two or three schedules of classification of "indirect expenses" or "establishment charges," as

* The Proper Distribution of the Expense Burden. The Engineering Magazine, New York and London.

presented by different writers or as in practical use in different works. Commonly they agree neither in amount of detail nor in grouping, and this is simply because they are regarded as abstractions—as inconvenient items which it is necessary to do something with; but what that something may be is not a matter of extreme importance. Where everything is a compromise, extreme accuracy is indeed impossible.

The error which dominates and vitiates all the usual and popular methods of dealing with indirect expense is simply "analysis." That is the rock on which they all founder. For the purposes of the accountant this analysis is sufficient, because the accountant is concerned neither with the efficiency nor the improvement of production.

It does not matter greatly to him whether a particular item of expense is due to inefficient power distribution, or to worn-out machinery, or to buildings imperfectly adapted to their uses. To him an expense is an expense; but to the production engineer it may be more than an expense—it may be a revelation. Yet, as long as we persist in looking on all the activity and all the expenditure going on in and about a works as due to production, so long will the accountant's point of view necessarily hold the field. As long as we shut our eyes to the fact that actual production is the last organisation in a chain of separate organisations, so long will the present confused ideas about indirect expenses or establishment charges hold their ground unshaken.

It is perhaps only those who have had the opportunity of observing manufacturing industry in its primitive forms, as still carried on in some parts of Europe, who will be able at once to recognise the difference between the main function of the manufacturer in producing some specific product and his *subordinate* but still very distinct functions preceding and accompanying his manufacturing function. In a large modern manufacturing concern these functions are, in fact, not easy to recognise without considerable study; but in the progress from the most primitive forms of industry up to the modern scale of manufacturing activity, it can easily be seen how one after another of these functions is assumed and incorporated with the direct productive function.

It has been said, above, that cases exist where labour is the *only factor* of production. It may also be said that these are cases where the productive function exists unconnected with any subordinate function. Where an independent worker is on some one else's premises, doing work either by day or piece, with his own tools (as, for example, a jobbing carpenter), he represents production in its simplest

form. But the moment we pass beyond this stage other considerations come into play. Supposing that he works on his own premises; the element of rent at once enters into the calculation. For each kind of work there is a limit beyond which the worker cannot afford to pay more rent. A stage further is the use of power. This, too, may be rented at so much per horse power, and the question of a cheaper or dearer source of power may make all the difference in the world to the isolated worker. It is perfectly easy to recognise that two variable elements have now entered into production, entirely independent, one of the other, but each having an important bearing on economy of production.

Yet these elements do not affect the function of the worker as producer. He is still a producer only, and has not assumed any other function. He can change his workshop, and he can change his source of power, because he merely pays fixed sums for the "services" of floor-space and power which the landlord and the power company render to him. (We are assuming one man and one machine throughout this argument).

Now let us suppose that his ambition increases. He is not satisfied with the charge made to him for power. Some one suggests to him that he would do better for himself to put down a gas engine and supply himself with his own power. By doing so he immediately passes beyond the simple productive function and assumes a new function—that of a supplier of power. Let us therefore look into this development closely, because it represents in a very small and incipient degree the complication of functions found in a large modern manufacturing enterprise.

Up to that point the production factors entering into his output were three—viz: (1) his own time, (2) his rent, (3) the cost of his power per horse power. Each of the two latter is expressible as a distinct element in the cost of his product. Obviously, it would be senseless to lump rent and power together and express them as a percentage of wages cost. In this single case it is easily seen to be senseless, though in more complex conditions the same kind of consolidation of things that have no real relation is done every day.

When he has installed his gas engine the problem takes on a more modern and familiar aspect. It has become relatively complex—if we like to make it so. What, we may enquire, is the proper method of arranging his cost accounts? The familiar way would be to analyse his indirect expenses—so much for rent, so much for gas, for lubricating oil, for ignition tubes, for repairs to the engine (which we may imagine to be a second-hand one in poor condition, requiring

frequent repair); to throw all the separate items into one "burden" or "establishment charge," and to allocate it as a percentage on wages cost by one or other of the well-known and much debated methods. In other words, we confuse his function as producer with his function as supplier of power, and having mixed them up inextricably, we contentedly express the result of the jumble as a percentage on wages or time.

The alternative to this is perhaps obvious. It is to keep the two functions he has assumed perfectly distinct. Instead of consolidating his indirect expenses, he would do much better to preserve the more primitive form of his costs, and continue to recognise three factors as before—viz.: Time, rent and power. In order to do this satisfactorily he need take no more trouble. All he requires is to keep all his expenditure on power (that is, all the cost entailed by his function as supplier of power) separate and distinct from his other expenditure, and to express it *not as a percentage on time, but as a rate per horse power consumed.* He will then obtain his power factor exactly in the same form as he originally had it when he rented his power, not from himself, but from a supply company. Notwithstanding his new function, his costs will be in the same form and directly comparable under either régime.

Advantages of Production Factors.

The three factors of his production, being still separate and distinct, will afford him much food for thought. We will assume also that he is in touch with brother workers, broad-minded enough to discuss between themselves all points of their work with a view to improvements and economies, and we will ask which method—the "averaging" percentage method, or the "production-factor" method, will give the best basis for intelligent discussion, and for recognition of actual facts.

If three or four such "little masters" may be supposed to meet together to talk over their methods and compare notes as to their relative efficiencies, it is obvious that if each of them knows only two facts about his production—viz.: (1), his labour cost; (2), the percentage of his total expenses to his labour cost—they will not be able to compare results favourably, for even though one of them discovers that his percentage is higher than that of his friend, he will not be enabled to say why. But on the other hand, if the three production factors so far introduced are kept entirely distinct, then intelligent comparison becomes at once possible. The rent factor of one is perhaps higher than that of another. The power factor of a third may be greater than that of his fellows. The introduction of the gas

engine, for example, when reduced to a power factor, may easily be seen to be a mistake, whereas if treated as an ordinary item of expense that unpleasant truth would have had a strong tendency to conceal itself.

Again, our supposititious worker may rent a piece of ground and erect upon it an iron workshop for himself. This introduces a further complication and is another step toward the complexity of modern manufacturing concerns. In addition to his purely productive function, he has already introduced another function, that of supplier of power, and by this new step he introduces yet another, that of owner of buildings. He still pays rent for his ground, and has not yet become a landowner, but his new function must obviously call for representation by a "buildings factor" in addition to the power factor already established. For it must not be forgotten that this, too, may be a retrograde step. When all his transactions with regard to his building are collected together and summed up and translated into a building factor, they may collectively prove to be more costly than the simple rental plan was originally. The cost of repairing, painting, and lime-washing, together with the interest on the cost of the building, are, of course, components of this new factor.

Obviously, the rise and fall of either the buildings factor or the power factor are entirely independent of each other. By no stretch of imagination can they be considered as having any interrelation. Consequently, their relations with the labour factor are entirely individual. To lump them together and express them as a percentage of wages cost is seen to be a mistake, *for whatever significance they may present when kept apart is demonstrably lost when the two sets of figures are mingled.*

If it is easily seen that his prime cost should not suffer because he has made an error of policy in becoming a building-owner—if it is admitted that prime costs should always be distinguishable from all other elements for the sake of clearness and comparison—then the way is prepared for the argument that it is equally wrong in principle to throw all expenses other than prime cost into a common indistinguishable fund that may easily become a perfect well for the hiding of errors in policy. Excessive labour cost is a well-defined offence against the rules of good management, but how many have enquired as to an excessive power factor or an abnormal buildings factor? It is true that for the most part (but not always) labour cost is by far the greatest *single* factor of production. But the aggregate of the other factors is nearly always equal to, and sometimes exceeds,

the labour factor, without any standard of comparison and control being possible under existing methods of organisation.

The tendency of modern business is towards standardisation in most departments, but in organisation the process has not even been begun. The cry that each business demands its own special organisation is about as true as that each machine shop demands its own special tools. It may demand *some* special tools, but standard planers, lathes, and milling machines will probably form the larger bulk of its equipment. The advantage of regarding production from the point of view of its component factors is that it will build the great framework and structure of all similar business in the same way. It will standardise a large number of elements that are now extremely varied and even fanciful, and it will enable comparisons to be made that are not at present possible.

No one at the present time can say what is a standard buildings factor proper to a machine shop, a foundry, or a rolling mill, and this implies that no one is in a position to say that this or that particular instance is an example of inefficiency when it is discovered. In electrical power generation great benefit has resulted from the frequent publication of figures representing the production-costs per unit of power delivered at the mains, thus stimulating a healthy rivalry between stations to keep a close watch on their expenses. The comparatively few factors entering into central-station work have made this easily possible, but though in the case of manufacturing enterprises the factors are more numerous and complex, the benefit to be obtained by defining and keeping those factors separate would be even greater.

From the illustrations given the outline of the production-factor method of organisation will now be seen. Its controlling principle is not the "analysis," but the *keeping separate*, of various functions filled by the manufacturer which are not in themselves purely manufacturing processes. There is no very subtle or involved idea in this. It is a simple recognition of facts that, somehow or other, in the course of progress toward highly organised manufacturing have been overlooked and forgotten. The functions of the manufacturer as landowner, as landlord of buildings, as supplier of power, and many similar things, have nothing to do with his manufacturing function. It follows that by keeping them separate we have a strong chance of coming ultimately to the view of the facts relating to production unmixed with elements that do not belong to them. That will be a clear gain, but it will be no less important a gain if we are enabled to establish a basis of comparison for the non-manufacturing functions.

Taking the questions of buildings and power alone, such problems as the relative efficiency of different methods of construction, of whether it would pay to rebuild particular shops, of comparison between different forms of power generation and distribution, of the scrapping and replacement of power plant, would have valuable light thrown upon them. Comparison with other works and other localities would be facilitated. A whole group of important items now entirely hidden and obscured by consolidation with each other would be brought under discussion. And, last but not least, these items would cease to obscure the real facts about manufacturing costs, and wherever inefficiency existed it would be placed on the right shoulders.

Before going into detailed explanation of Organisation by Production Factors, it will be desirable to consider the question of what is meant by the term "organisation" and the term "costs." As to the latter, especially, some confusion of thought exists, because it is hardly recognised in sufficient degree that there are several quite diverse objects sought to be attained by costs. They are used for several different purposes, and each of these purposes requires them in a different form. My own view is that it is the business of organisation to regulate production, and the business of costs to represent facts and nothing but facts.

This statement may seem to be a truism, but unfortunately many people believe that costs may be usefully manipulated and twisted and averaged so that they cease to represent what actually happened and come to represent what in the opinion of their manipulator ought to have happened. A simple illustration of this is the argument not infrequently met with, that where machine rates are in use a job done on a large heavy planer that could have been done on a lighter machine should not be "penalised" by bearing the burden incident on the large machine. It would be just as proper to insist that where premium work is in use a piece of work should always be costed at its lowest recorded rate of production. The fact is that costs must always be read, as the artist is said to have mixed his colours, "with brains." But as a prelude to an intelligent reading of them, an unflinching representation of facts—of what actually did happen—appears to be a fundamental necessity. In the next article the bearing of production factors on the different uses of costs will be further considered.

INCREASING THE EFFICIENCY OF THE ELECTRIC-MOTOR DRIVE.

By Howard S. Knowlton.

Accurate data of performance, power consumption, or costs are always warmly welcomed by industrial engineers. Mr. Knowlton's article is a digest and review of a very large series of tests of electric driving, and is valuable not only for the results given but as an illustration of methods by which the fitness of any given installation may be determined.—THE EDITORS.

IN the application of the electric drive on a large scale, one of the most important considerations is the selection of the type and size of motor which will operate with the highest permanent efficiency of production. In making the initial installation it is difficult to forecast the requirements of the future, and as the size of the plant increases, the more probable it becomes that it will pay to check up the fitness of the individual motors from time to time, in order to avoid the injury of the electrical equipment through growing loads on the one hand, or the retention of idle capacity, costing heavily in fixed charges and diminished operating efficiency, on the other. Speed and economy of production per unit of output are almost always of greater importance than the power consumption required to perform a given operation; and the ample powering of tools, whether driven individually or in group, is a primary requisite. Inadequate capacity, improperly applied methods of driving, unsuitable types of motors for the kind of work in hand, and over-capacity, are all costly, however, and from the broad standpoint of total plant economy it is exceedingly desirable that the efficiency of the drive shall be maintained close to the engineering and manufacturing maximum. Fortunately the accuracy of commercial electrical-measuring instruments permits the fitness of individual motor installations to be analyzed with success, the cost of such investigations being small in relation to the benefits. In the majority of cases the engineering staff of an industrial plant can make these tests without outside assistance, although in some instances, where an exhaustive analysis is to be made of the efficiency of the entire process of manufacture, the services of the specialist may be necessary.

However carefully the initial requirements of a motor installation may be worked out, changes in the conditions of its service are cer-

tain to modify the accuracy of the original selection of apparatus. The use of higher speed tool steel; changes in the order of manufacturing processes; modifications in the quality and character of the material machined; alterations in the sizes of holes to be drilled in a given time; improvements in lubrication and shafting arrangement; addition of machines to initial groups driven by fixed sizes of motors; changes in the period of working certain parts; use of greater blast pressures in pneumatic equipment; and different combinations of apparatus and tools to produce new or modified staples or routine products—all these have an important bearing upon the motive-power requirements. The kind of industrial plant makes little difference as to the advisability of analyzing the effectivenesss of the tool drive after the shops have been established. Each case must obviously be worked out upon its own merits, but at the same time the methods of treatment followed in one instance are more or less applicable to others. Individual tests will vary in different establishments, but the lessons of tests in one shop are easily made of general significance.

A representative series of tests, made by Professor Albert Kingsbury, of the Worcester Polytechnic Institute, showing the modifications desirable in the electric driving of a large group of railroad shops have recently been placed at my disposal by the courtesy of a trunk-line officer, and so well do they illustrate the methods by which the fitness of a concrete installation may be judged (besides showing the power requirements of specific machine operations) that they have been utilized as the basis of the present article. The shops at the time of the tests, comprised nearly a score of buildings occupying a total ground area of 19 acres, maintaining and manufacturing the rolling stock of a system many thousands of miles in extent. Both group and individual driving were employed, current for lighting and power service being supplied from a central power plant having a maximum radius of power transmission of 1,800 feet. Both alternating and direct-current apparatus were employed, the latter being used only for cranes and for a few individual tool drives. The alternating current was three-phase, 60 cycle, 550 volts, and the direct current at the motors averaged about 250 volts. The alternating-current motors aggregated 4,491 horse-power and the direct-current motors 821 horse-power. All except three of the alternating motors were of the constant-speed induction type, the exceptions having variable secondary resistance external to the motor frames. The range of sizes was from 3 to 100 horse-power. One hundred horse-power of the direct-current motors were used for individual tool drives in the locomotive shop with 2 to 1 speed variation by field resistance, the rest of the

motors of the direct-current system being used on the cranes and hoists. The following table shows the distribution of all the motors, in horse-power:

ALTERNATING-CURRENT INDUCTION MOTORS.

Shop.	Individual Drives.	Group Drives.	Fans and Blowers.	Total Horse-Power.
Planing mill	800	500	340	1,640
Cabinet department	90	139	50	279
Power house	...	...	80	80
Truck shop	10	125	...	135
Car machine and freight	55	190	...	245
Blacksmith	297	...	405	702
Gray iron foundry	3	23	50	76
Upholstery	...	10	...	10
Passenger car	...	10	...	10
Frog and switch	148	40	42	230
Boiler	118	27	40	185
Locomotive machine shop	220	574	...	794
Pattern	...	20	...	20
Wheel foundry	...	...	65	65
Transfer table	20	...	...	20
Totals	1,761	1,658	1,072	4,491
Per cent of total	39.2	37	23.8	100

DIRECT-CURRENT MOTORS.

Shop.	Individual Drives.	Cranes.	Totals.
Midway crane	...	110	110
Wheel foundry	...	33	33
Locomotive machine	100	...	100
Locomotive shop	...	503	503
Gray iron foundry	...	65	65
Frog shop	...	10	10
Totals	100	721	821

The high efficiency of the induction motors, their durability and relatively low costs for repairs, made them preferable to other types of motors where the operating conditions permitted their use. They operate best under the requirements of nearly constant speed and load, and are not readily adaptable to variable-speed service, the latter being secured only by a sacrifice of efficiency. When induction motors are given variable-speed characteristics their speed depends too largely upon the load. They are well adapted to driving wood-working machinery in general and all kinds of machinery in groups, or single machines where the load is fairly constant. If, however, a large num-

ber of induction motors are run underloaded for long periods, the power factor of the system is made too low, and this requires the generators to be made abnormally large in order to carry the current without overheating. At the same time the average efficiency of the system is made low and the voltage regulation bad.

The power-factor tests at these shops showed that the ratio of real to apparent electrical power was not over 60 per cent. The motors were found to be working under average loads of about three-tenths of their normal capacity, with an average motor efficiency of about 79 per cent; although the average efficiency would be 85 to 87 per cent if the motors worked between half and full load, while the corresponding power factors would be 78 and 88 per cent. The safe output of the generators in kilowatts was only three-fourths as great with the power factor existing as it would have been with an 80 per cent power factor. The low average motor load and the consequently low power factor and efficiency were due partly to the nature of the work at the shops, and partly to the installation of larger motors than the tests showed to be necessary for the developing work of the plant.

Of the large number of tests made only a few illustrative ones may be printed in the space available. In each case the conditions under which the drive is made are stated, with the test results and recommendations:

BLACKSMITH-SHOP BLOWER TEST.

Machine: Sturtevant No. 10 pressure blower, 13½-inch pulleys, supplies blast for 55 forges.

Motor: 30-horse-power constant-speed induction type, 900 r.p.m., 13-inch pulley.

Condition: 34 forges with fires in ordinary operation. Air valves closed on remaining forges.

	Motor Input		Motor	Motor	Fan
Test.	k.w.	h.p.	output h.p.	r.p.m.	r.p.m.
1	14	18.8	15.9	960	903
2	15	20.1	17.0	947	890
3	14	18.8	15.9	944	887
4	15	20.1	17.0	...	...
5	13	17.4	14.6	...	...
34 forges with fires in ordinary operation; air valves wide open on rest.					
6	20.4	27.3	23.3	925	870
7	19.0	25.5	21.8	...	...

Recommendations:—If all the forges were in service the power would not exceed 20 horse power. The 30-horse-power motor works with good efficiency from 15 to 20 horse power, but a 20-horse-power machine would take care of the work more efficiently.

Blacksmith-Shop Double Punch and Shear Test.

Machine: Double punch and shear.

Motor: 10-horse-power constant-speed induction, 1,200 r.p.m. Elements of drive, motor pinion 6-inch pitch diameter, gear 24-inch pitch diameter, pulley 22-inch diameter, 6-inch cotton belt to 28-inch pulley on shaft carrying two flywheels, and pinion engaging with main gear, pinion 14 teeth, gear 90 teeth, 2½-inch pitch, 7-inch face. Flywheel, 48-inch outside diameter, 4½-inch face, rim 8 inches deep, 206 r.p.m.

Rams balanced 2-inch stroke, 32 cutting strokes per minute.

Test conditions.	Motor output h.p. max.	Motor output h.p. avg.	motor speed
1. Running light, rams not running	1.6	1.3	1230
2. Running light, rams running	..	2.0	....
3. Shear ram cutting ½ in. by 4 in. wrought iron	..	4.5	....
4. Shearing 1 in. by 4 in. soft steel each stroke	..	9.0	....
5. Punching 1 9-32 in. hole in 1½ in. soft steel	..	9.2	....
6. Shearing ⅞ in. round soft steel each stroke	..	3.0	....
7. Punching as above and shearing 1 by 8 in. soft steel	..	12.5	....

Remarks:—The machine ran light more than half the time of its service. Heaviest punching as above; heaviest shearing is on 1½-inch by 6-inch soft-steel bars. The 10-horse-power motor is larger than is necessary. A 7.5-horse-power motor geared to the flywheel shaft would be ample. It should be provided with internal secondary resistance giving about 10 per cent drop in speed at full load, thus utilizing the flywheel energy and equalizing the demands on the motor. The 7.5-horse-power motor would take but 75 per cent as much current as the 10-horse-power motor when running light, which is an important point where many machines are run light much of the time.

Planing-Mill Test.

Machine: 4-cylinder planer, Berlin top and bottom cylinders, each three 30-inch knives, 7-inch circle; side cylinders, each three 15-inch knives, 7-inch circle.

Motor: 30-horse-power constant-speed induction type, 720 r. p. m., connected by friction clutch to floor countershaft.

Test conditions.	Input k.w.	Output h.p.	R.p.m. cyls.
1. Running motor light, clutch out	4.2	1.7	....
2. Running machine light	15 to 18	16.3 to 20.2	3228
3. Planing 10 in. by 10 in. by 12 ft. oak wet. Intermediate feed, 28 ft. per minute, avg. reduction 9-32 in. on each of 4 sides	55	60	3370 top 3430 bttm
4. Planing 10 in. by 10 in. by 12 ft. oak wet, feed 28 ft. per minute, avg. reduction 5-16 in. on each of 4 sides	67	70	....

Remarks:—Knives all sharp at time of test. Room temperature, 55 degrees F. Heavier work done at all times. With dull knives and in colder weather motor would be too greatly overloaded. Recommended a 75-horse-power motor, which would give 112.5-horse-power output at 50 per cent overload, and also better starting conditions. Friction clutch is too small to be useful.

PLANING-MILL GROUP TEST.

Machines: 1 Breenlee hollow-chisel mortising machine, 1⅜-inch spindle, 2,625 r.p.m., largest bit 1¼ inches; 1 Fay and Egan band saw, cast-iron wheels, 304 r.p.m. 1-inch saw, 3 teeth per inch.

Motor: 20-horse-power constant-speed induction type, 900 r. p. m., motor shaft extended carrying friction clutch pulley for driving mortiser and tight pulley for driving saw.

Test conditions.	Motor k.w.	Input h.p.	Output h.p.
1. Running both machines light	4.4	5.9	4.5
2. Mortising oak, 1¼ in. bit and sawing 12 in. oak, maximum work for both	5.2	7.0	5.6
3. Running mortiser light and sawing 12 in. oak	4.6	6.2	4.8

Remarks:—The 20-horse-power motor should be replaced by a 7.5-horse-power motor, which would have a fair margin of power for starting the machines.

The above tests, cited in detail, show the thoroughness with which it is necessary to investigate problems of machine-tool driving in order to obtain an intelligent idea of the requirements. In the past there have been far too many tests made in which the full particulars of the mechanical drive and feeds, cuts, and speeds have been slighted, with the result that the data obtained have had only an approximate value. In order to show the manner in which the changes were determined in the shops under consideration the summarized results of several more investigations may be given:

BLACKSMITH-SHOP, BLOWER TEST.

Machine: Sturtevant pressure blower No. 9, diameter 50 inches, blades 15 inches wide, discharge of pipe 22 inches diameter, pulley, 12 inches diameter, furnishing blast for twelve oil furnaces.

Motor: 75-horse-power constant-speed induction type, 720 r. p. m., pulley 24 inches diameter, 12-inch double leather belt.

Tested with three furnaces in operation and air valves on rest open. The power required was greater than would ever be demanded in service. Motor output varied from 26.2 to 31 horse power. Conclusion was that a 30-horse-power motor would serve in place of the 75-horse-power machine, and considering that the load factor would not be over 75 per cent, there would still be a margin for a 33 1-3 per cent increase in the capacity of the furnaces supplied by the fan.

BLACKSMITH-SHOP BLOWER TEST.

Machine: Sturtevant pressure blower No. 10, diameter 60 inches, pulley 14 inches.

Motor: 100-horse-power constant-speed induction type, 600 r.p.m., 28-inch pulley, 15-inch cotton belt, slack.

Test conditions: Fan supplied ten large oil furnaces and two blacksmith forges, all but one valve wide open. Motor output varied from 34 to 42 horse power. Concluded that the maximum load in the test was greater than would be required in service. A 40-horse-power motor would carry the load.

PLANING-MILL DUST FAN.

Machine: Sturtevant steel-plate full hoisting fan, diameter 5 feet, width 24 inches, 20-inch inlet pipe, fan speed 817 r.p.m.

Motor: 30-horse-power induction, constant-speed, 900 r.p.m., 13½-inch pulley, 8-inch double leather belt to 14-inch fan pulley.

Motor output on test 21 to 23 horse power. It was expected that more dust pipes would be added to the system as new machines were placed, and the fan speed would probably have to be increased slightly. No change in the motor was recommended, though a 25-horse-power machine would have sufficed for the requirements at the time of the test.

CAR MACHINE SHOP.

Machines: One Bertram car-wheel lathe, one car-wheel lathe, Blank R.R. Co., one 15-inch engine lathe, one double emery-wheel stand, two 2½ by 10 inch wheels, one grindstone, 4 feet diameter.

Motor: 15-horse-power induction, constant-speed, 600 r.p.m.

Test showed a maximum motor output of 13.7 horse-power, obtained by selecting wheels requiring specially heavy cuts. The lathes are run on piecework, and are worked nearly to their maximum capacity, each turning three to four pairs of wheels per day. They were too light to utilize much greater power. A 10-horse-power motor would have been the best size for the group as then operated, but a 12½-horse-power motor would be advisable if the cutting speeds should be increased to 10 feet per minute, instead of remaining at 8 feet. The best results would be obtained by gearing a 7½-horse-power motor to the Bertram lathe, and a 10-horse-power motor to the other car-wheel lathe. Both motors to be direct-current type.

Only the briefest possible reference can be made to other tests, quoting mainly the recommendations made:—

Bertram four-head planer, 54 inches by 12 feet, gear driven by 20-horse-power induction motor. Tests showed that the tool block would not hold the tool for a cut more than 11-16 inch deep, which was much heavier than the ordinary cuts. It was not to be expected that four such cuts would be required at once. Assuming three heavy

cuts, the motor output during the cutting stroke would be 18.6 horse-power, which is well within the capacity of a 15-horse-power motor. Also, if the weight of the work were as great as that of the table, the total momentum would be increased about 60 per cent, which would produce an increase of about 25 per cent in the motor output at reversal, and also in the time for reversing. With a 15-horse-power motor the maximum overload would not thus exceed 25 per cent, either while cutting or reversing. If extra gears were added, giving a higher table speed when needed, the 20-horse-power motor would be required.

Niles 104-inch driving-wheel lathe. Motor, 30-horse-power induction, speed varied by external secondary resistance, Morse-chain drive, four gear speeds. Tests, very exhaustive, showed that heavy roughing cuts on 56-inch wheels or larger could not be carried for any considerable time except with the slowest gear speed. It appeared that if roughing cuts were to be taken on 78-inch wheels it would be necessary to use the slow gear speed and also to reduce the speed of the motor by the controller by 30 per cent, which would require an increase in the motor torque of 41 per cent; thus the maximum motor input would correspond to a 60 per cent overload, and as the time of the cut would not be over 50 minutes the motor could carry it safely. The motor would have ample time to cool during the lighter cuts and while changing work. From this it appeared that the motor capacity was well suited to the work in hand, but the motor type was one that is not generally considered the best for machine tools. Its characteristics are better suited to crane service. Its speed could be varied by the controller, but on the lower notches the resistance of the driven machine affects too largely the speed; if the load was removed the motor would run at nearly full speed on any notch of the controller. The speed reduction by the controller was obtained by a loss of power, the motor efficiency being lower on the lower notches of the controller. The type of motor does not compare well as regards controllability and efficiency with the direct-current shunt-wound motor with variable field resistance.

Shanks four-head, 75 inches by 30 feet planer. Motor, 20 horse-power, induction type. Test showed that the large input required on reversal slowed down the motor to nearly its falling out speed. If the planer were used for short work the motor would be rapidly overheated, owing to the frequent reversals. The motor would serve without serious overheating on such work as locomotive frames, but it would be better to replace it by a 30-horse-power motor if the planer is to be used on short work to any degree.

Bertram three-head slotting machine for locomotive frames. Motor, 20-horse-power induction, speed varied by external secondary resistance. Test showed that it was desirable to increase the speed of the machine so that the average cutting speed would be at full stroke about 40 feet per minute. These heaviest cuts would greatly overload the motor in service during the tests. The best arrangement would be to use three 12½-horse-power variable-speed direct-current motors. The output of the tool would be considerably increased by this method, as each cutting tool could be worked always at its most effective speed.

By reference to the table of motor distribution it will be seen that over 76 per cent of the motor power is assigned to individual drives and group drives, not counting the fans. The groups are small in each case. In each instance the motor is required to be of sufficient power for the maximum load of the machine or group; but with most of the machines and groups in a plant of this kind the maximum demands do not occur often, and the average demand is small compared with the maximum. This is the chief cause of the low power factor and the low efficiency of the alternating-current system, and it cannot be remedied in the shops under consideration without long and careful study of the tool development and distribution, combined with improved methods of driving determined by experience.

The tests showed the induction motors to be in most cases at least ¼ too large, and in some cases 2½ times as large as necessary. The average of the tests was about 37 per cent excess motor capacity. The tests showed that if the maximum load on the induction motor occurs only at intervals and not for long periods this maximum should be an overload for the motor; the shorter the proportionate time of the maximum load, the greater the allowable overload. This relates particularly to individual drives. For lathes and boring mills the maximum motor overload should be about 50 per cent; for planer the overload at reversals of the platen may ordinarily be as high as 75 per cent. The object of this is to make the average load on the motor fairly high.

For group drives the groups should comprise as many machines as possible, within the limits imposed by the available space and the number of machines required to be operated at once, in order that the load factor for the group may be as nearly constant as possible, operating the motor close to full load. The company keeps a card record of all motor tests and changes and is thus in a position to check at any time the efficiency of its machinery, as well as to follow the improvements in the manner of driving which experience shows to be desirable.

GRAPHITE MINING NEAR LA COLORADO, SONORA, MEXICO.

By Frank L. Hess.

Mr. Hess is a specialist in the examination of mineral deposits, in the service of the United States Geological Survey. His article is published with the consent and approval of the Director.—The Editors.

THE Santa Maria graphite deposits, so called from the name of a grant upon which they are situated, are located about 20 miles south of the mining town of La Colorado, in central Sonora, Mexico, and are owned and operated by the United States Graphite Company of Saginaw, Michigan. The deposits were discovered in 1867, and work was begun on them in 1891, though commercial operations did not commence until 1895, since which time the present company has operated the mines. From the United States they are reached from Benson, Arizona, over a Southern Pacific branch which, as soon as it crosses the international boundary, is known as the Ferrocarril de Sonora. When going to the mines it is ordinarily best to stop at Hermosillo, where a good night's rest can be obtained at a comfortable hotel. On the following day the journey is resumed southward to Torres, and from there over a narrow-gauge railroad to the town of La Colorado. From La Colorado travel is a little east of south for 20 miles over very good wagon roads, along which there are neither houses nor water. The country is dry and little more than a desert except for three months—July, August, and September, during the rainy season, when it is green and blooming.

The vegetation consists of thorny trees and shrubs, with a still thornier *cholla*, a form of cactus 2 to 4 feet high, which grows abundantly, and other cacti which to the northern eye are weird and interesting. The trees are largely green-barked and ordinarily are of low growth, being only 15 or 20 feet high, and, for a distance of 12 or 15 miles, nearly all the large ones have been cut for wood to be used at the gold mines of La Colorado, which are among the important mines of North America. The *palo verde* and the *palo fierro* make good firewood, especially the latter. After leaving the town 10 or 12 miles behind an occasional *palo santa* of taller growth and thicker trunk is

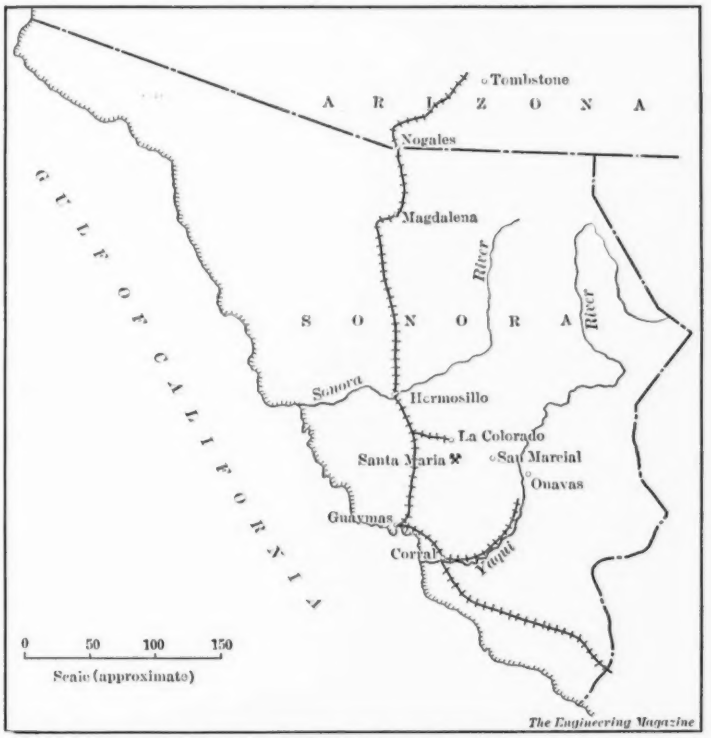


FIG. 1. SKETCH MAP OF THE STATE OF SONORA, MEXICO, SHOWING LOCATION OF THE SANTA MARIA GRAPHITE MINES.

to be seen. At the time of my visit in March it was just coming into bloom with a sweet-scented white blossom, opening flatly, and about 2 inches across.

During most of the year the climate is exceedingly dry, with about three months of rainy season. The temperature is high during the summer time, and though it is hard for some people from a northern country to endure, there are many Americans scattered through the State. Frost never occurs and such tender plants as tomatoes and similar vegetables grow from year to year, but water is so scarce that little agricultural utilization can be made of the climate and soil, which otherwise would be wonderfully productive. Work can be carried on in the open all the year through, the greatest trouble being the heat of the summer. During the winter the weather is mild and pleasant.

Forage and food of all kinds for work animals is high, alfalfa costing $40 gold per ton. Only a small amount of grain seems to be fed. Little farm produce of any kind is raised in the region owing to the lack of water, and feed is obtained from Hermosillo and other points.

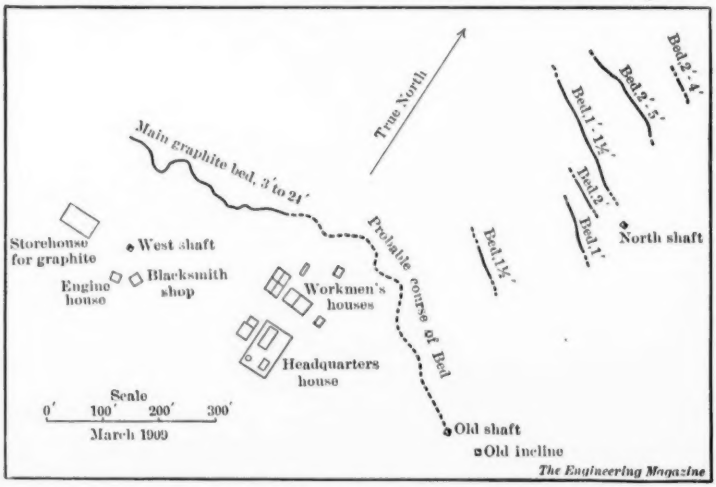


FIG. 2. PLAN OF THE SANTA MARIA GRAPHITE MINES, NEAR LA COLORADO, SONORA, MEXICO.

The road from La Colorado to Lapiz, as the mines are known locally, runs along a broad, flat valley on the western side of which are hills rising from 200 or 300 to perhaps 1,000 feet in height, on many of which a flow of lava or *mal pais* may be seen. The general contour of the country is rounded, except for the lava-covered peaks. The old flows upon these break off in abrupt precipices, appearing from a distance to be from 20 to perhaps 100 feet high. Here and there in the distance jagged cones appear, giving the impression that they are old stumps of volcanoes from which the lava came. Most of the rock, where visible in the valley, is a rotten granite.

Near the graphite mine the rock changes to sedimentaries, sandstones around the mine itself, and a little to the southwest heavy limestones. The surface of the ground is strewn with quartzite boulders, which are hard and glassy. Some of the boulders contain pebbles 1 inch or 1½ inches in diameter, but most of them are of much finer-grained material. The rock in places is much softer, so soft, that it can almost be worked with a pick, and is apparently the same material as the boulders which everywhere cover the surface. It seems probable that the boulders are hardened by exposure to the hot sun.

The headquarters house and the main shaft are situated upon a hill, perhaps 100 feet above the valley. Aneroid barometer readings showed the house to be 475 feet above La Colorado. The elevation above sea level is about 1,300 feet.

Formerly graphite was worked at an exposure (see Figure 3) directly east of the headquarters house at the foot of the hill, but, owing to caving, it was found best to sink shafts at other places. At present work is being carried on from two shafts, known as the West shaft, about 700 feet west of the headquarters house, and at the North shaft, about the same distance northeast of the house. A number of beds of graphite occur, at least seven. Only one is exposed in the West shaft, but in the North shaft six beds have been cut. Around both of the shafts everything is covered with a fine, glossy coating which gives a metallic luster in the bright sunlight. Even the men's clothing, hands and faces take on somewhat of the same metallic sheen.

FIG. 3. OUTCROP OF GRAPHITE BED AT SANTA MARIA MINES.

WEST SHAFT.—The West shaft is an incline sunk at an angle of about 50 degrees, with levels 25 feet apart. The shaft is driven beneath a granite bed which here runs approximately east and west, dipping north. The shaft is dug on the under side of the bed so as to avoid

as much as possible the slipping of the rocks. Upon descending the shaft a rise in temperature is at once noticeable at this time of the year. By the time the bottom is reached (175 feet) clothing becomes a burden and the perspiration flows profusely, so that the men work clad only in a pair of trousers, with sandals made of a thick piece of cowhide, having a thong passing between the first and second toes and others from the heel, all tied about the ankle. However, the temperature is said to be gratefully cool compared with that of the outside air during the summer, and in the winter there is considerable competition between the native miners, who are very sensitive to cold, as to who will first get into the warmth of the mine. Here and there niches are cut in the walls and in them are rude wooden crosses decorated with pieces of newspaper before which the miners pray for safety.

Both the West and North shafts have struck wet ground, though there is not enough water to make pumping necessary.

The graphite bed, as at present mined, reaches from 9 to 10 feet in thickness. It is extremely irregular in strike, sharp curves coming closely together. Probably there are more of these folds along the strike of the vein than along its dip, though they occur in both directions. As would be expected, owing to this folding the vein is here and there cut entirely off or reduced to a mere stringer. A corresponding thickening is made in the veins at other points, for the graphite is not lost through the folding and pinching, but the part that is squeezed out in one place is forced into the bed at another, thickening the mass correspondingly. One lenticular mass of graphite, which has been worked out, reached a thickness of 24 feet, with a breadth of 75 feet vertically and 150 feet horizontally. On the sixth level (102 feet vertical depth) a mass was being stoped at the time of my visit which was 9 feet thick. It had been mined from the seventh level almost to the fifth and had a width of perhaps 30 feet. The wall rock is in most places a sandstone, at points so fine-grained that it is shaly, and at others comparatively coarse. In places the wall rock is a white granite, from which dikes from ⅛ inch upward in thickness penetrate the graphite. At other places small lenticular masses of granite a few inches in length and one or two inches in thickness, which have been parted from dikes by squeezing, occur in the graphite. The walls are ordinarily smooth and polished, the graphite upon them looking like a fine, lustrous, black enamel. Here and there horses of the country rock jut into the bed owing to faulting on both sides and almost, or quite, cut off the graphite. In places lenticular

masses of sandstone which are very similar to the sandstone lenticles sometimes found in coal beds, are buried in the graphite. They do not, however, so far as I saw, have any persistent characteristic in their relative distance from the walls. This may be due to crushing having displaced them and given them new positions as regards the top or bottom of the bed. These masses reach 4 to 8 feet in length by 6 to 8 inches in thickness and are easily picked out of the mined material.

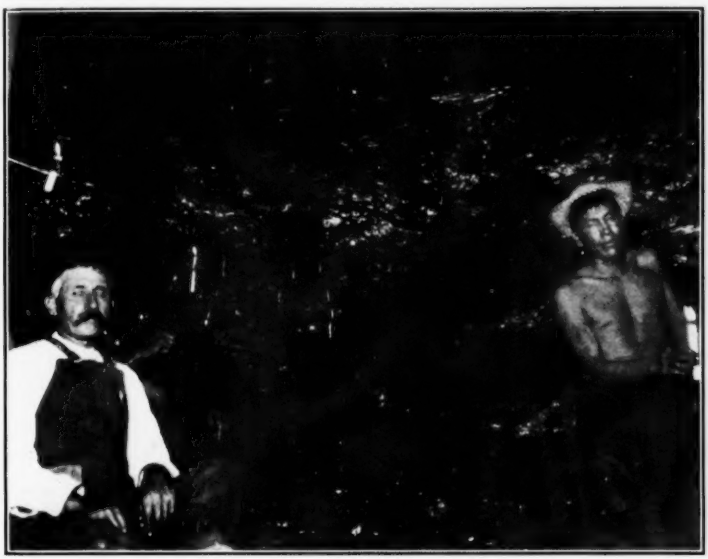


FIG. 4. STOPE IN WEST SHAFT, IN GRAPHITE FOUR FEET THICK.

DESCRIPTION OF THE GRAPHITE.—The graphite has the familiar sub-metallic, grayish-black luster which is unique and so characteristic that it can be described only as "graphitic." Much of it is in small lenticles produced by slipping within the bed probably due to the disturbance of the rocks, resulting from the intrusion of the granite. The lenticles are from an inch to several inches long and are easily broken into smaller pieces. Some of the fragments show a distinct parallel structure similar to that of coal, but with the stratification lines very close together. The graphite is so soft and friable that a large lump may be taken in the hand and crushed to small particles. It is velvety soft and smooth to the touch, and ordinarily no grit can be felt, except where the small granite dikes cut it, and this grit is

easily separated. Owing to the friability of the bed almost no explosives are necessary, most of the mining being done by pick and shovel.

The analysis of run-of-the-mine graphite as kindly furnished by Mr. Eugene McSweeney, President of the United States Graphite Company, is as follows:

ANALYSIS OF GRAPHITE FROM SANTA MARIA MINE, LA COLORADO, SONORA, MEXICO.

Carbon (C), all graphitic	86.75	per cent
Silica (SiO_2)	7.60	"
Iron (Fe_2O_3?)	.65	"
Alumina (Al_2O_3)	5.00	"
Total	100.00	per cent

It is said that selected samples will show 95 per cent graphitic carbon, and others can of course be picked which will run lower than the average as it is shown by the analysis quoted.

The graphite is apparently wholly amorphous, and shows no "flakes" like that mined in Pennsylvania, New York, and Canada, and no fibrous structure like that of Ceylon. Even under a high-power microscope it still shows only shapeless particles.

After being raised to the surface the graphite is spread out in the hot sun to dry, which it does in a short time, and then is thrown up in piles to await shipment.

THE NORTH SHAFT.—The North shaft, as stated, is about 700 feet northeast of the headquarters house. It is at the base of the hill upon which the house is built, and is sunk at an angle of about 72 degrees toward the northwest. The shaft is 142 feet deep, with levels 50 feet apart, on which drifts are run to the northeast and southwest to cut the country rock. Three beds are cut on each side of the shaft. An air shaft gives the workings better ventilation than those of the West shaft, so that the mine is much cooler.

The country rock is the same as in the West shaft, but in the rock are developed many more small andalusite crystals than were noted in the West workings, though this may be only apparent. The presence of the andalusite shows that the metamorphosed rock contains a considerable amount of alumina, and was therefore clayey. On the northeast side of the shaft the first graphite bed cut was about 20 feet, the second 130 feet, and the third about 230 feet from the shaft. On the southwest side of the shaft beds are cut at a distance of 20, 65, and 240 feet from the shaft. The best of the six is the second on the northeast. This produces excellent graphite and reaches 5 feet in thickness, but is in most places thinner. It is being actively mined.

The first bed is also of good quality, but reaches only about 18 inches in thickness, and is in most places much thinner. The third bed on the north is from 2 to 4 feet wide. The graphite is not so pure as the second vein or that mined in the west shaft and material taken from it is kept separate. It is well adapted for the coarser uses of graphite. On the west side of the shaft the veins are 2 feet, 1 foot, and 18 inches, respectively, in thickness. The last—that is, the third from the shaft—is of very good quality.

The veins are all more nearly vertical than the ones mined at the West shaft and are approximately parallel. Their strike is a little west of north. It is probable that none of them is the same vein as that being worked at the West shaft. No definite opinion can be given upon this, as the limited time at my disposal did not permit sufficient examination to work out the details of structure. The rocks are much disturbed and many things may have happened to the beds in the short distance of about 400 feet between the workings of the North and West shafts. Between the veins the sandstone is very soft and there is some talc in the joints, which all show more or less movement.

At places in both shafts the wall rock is somewhat impregnated with graphite. This may be due to the rock originally having contained some carbonaceous material, or to later impregnation from the beds. In other places the wall rock has been bleached until it is so white as to contrast strongly with the black graphite of the bed. Such an occurrence is in the third bed northeast of the North shaft.

No graphite veins similar to those of New York, Canada, or Ceylon have been noted.

OTHER WORKINGS.—The first work done upon the property was about 400 feet directly east of the headquarters house at the bottom of the hill. Here an outcrop of graphite (Figure 3) was worked, both by an incline and drifts. The photograph shows well how the bed varies in dip. The workings caved badly during a period in which the mines were not worked and it was not found feasible to open them again, so that new workings have been started. Excellent graphite was obtained from this bed and the company expects to work it again. An effort was made to run a drift from the North shaft to connect with the old workings, but it was found unsafe owing to the shattered condition of the sandstone.

Half a mile southwest of the headquarters house a shaft had been sunk where a small amount of graphite appeared under the limestone, but nothing was shown of value. Three poor fellows, who worked the prospect, were killed by the Yaqui Indians.

FIG. 5. WEST SHAFT OF SANTA MARIA GRAPHITE MINES.

The pile on which the boys are sitting, and the pile beyond, are graphite ready for shipment and the shed (of which the top is seen at the right) is also full of it.

Graphite is found in many places through Sonora, though no place is known where deposits are so pure and so large as on the Santa Maria property.

Forty miles northwest of the Santa Maria mine, 3 miles from the Ferrocarril de Sonora, are other graphite properties owned by an American company, but which have not been worked to any extent owing, it is said, to a deficiency in quality. Near Onavas, on the Yaqui River, 80 or 90 miles east of the Santa Maria property, I visited deposits of graphite which geologically resemble those at the Santa Maria— i. e., they are interbedded with sandstones which are intruded by granite and considerably altered, but so far the Onavas beds do not show commercial values. A few miles east of the Santa Maria deposits, at San Marcial, graphitic coal occurs with very hard anthracite. This has been described by J. S. Newberry,* to whom a specimen had been given

* Geologic Notes, School of Mines Quar., vol. 8, p. 334.

FIG. 6. MINERS AT THE SANTA MARIA MINES. THE PILE BEHIND THEM IS GRAPHITE READY FOR SHIPMENT.

with the information that the metamorphism was due to trap dikes. East of San Marcial, on the Yaqui River, near Toledo, a few miles above Onavas, are beds called anthracite, so graphitic that in a hot muffle with a plentiful supply of air it is said to take hours to burn a piece the size of a man's fist. Natural coke is stated to occur in the same neighborhood. It is reported that at the Carumari mine, a few miles above Onavas, and 3 miles west of the Yaqui River, while following a silver vein, coal was struck at a depth of 800 feet. Farther up the Yaqui River, there are said to be beds of softer coals which are of commercial quality and quantity. While not traced into each other, it seems probable that the coals and graphite belong to the same beds. The coal and consequently the graphite thus appear to be younger than at least part of the precious-metal deposits of the State.

From fossils Prof. Newberry * determined the beds containing the coal along the Yaqui River to be of Upper Triassic (Richmond) age.

It seems probable that the graphite deposits in various parts of the world have been formed in a number of different ways, and the derivation of some of them is not clear. At the Santa Maria deposits, however, the origin appears to be perfectly plain. The bedding of the

* Op. cit.

deposits with altered sandstone and shale in an approximately parallel series of at least seven graphitic members; the lenticular inclusions of sandy material, common in coal beds; the finely parallel structure like bedding planes in some pieces of graphite; the large area over which the same or similar beds are found; and the different phases of graphite, anthracite, coke, and coal found at various localities in what seem to be parts of the same beds, leave no doubt that the deposits have been formed from coal beds. The unlikeness in quality and thickness of the various beds is a common characteristic in parallel coal seams.

FIG. 7. MINERS' FAMILIES AND SHACKS AT THE SANTA MARIA GRAPHITE MINES.

The cause of the change from coal to graphite was evidently the granite which is intruded into both the sandstones and graphite beds, and forms the country rock over considerable areas. In places it is the wall rock and granite dikes cut through the beds of graphite. At the time of the intrusion of the granite, the rocks were necessarily greatly deformed. The coal beds would crush and slip most easily, and show the greatest effects of disturbance. Hence the graphite occurs in a finely broken mass showing numberless planes of movement. This is why a large piece may be easily crumbled in the hands.

In places the roof, or hanging wall, of the mine is what is known to the miners as "heavy"—*i. e.*, liable to fall, and timbers must be used, though in general this is not necessary. Where the chambers are large the need for timbering is of course greater. Oregon fir in sizes from 6 inches by 6 inches to 8 inches by 8 inches is used, and costs about $40 gold per thousand laid down at the mine. Owing to the large size of the timbers required where considerable lengths must be used in the thick parts of the bed, the use of steel I-beams has been

considered. It is said that such beams of German, English, or American manufacture can be purchased more cheaply in this part of Mexico than in the United States.

For hoisting the graphite 10-horse-power Weber combination gasoline engines and hoists are used with ½-inch steel ropes, and have been found very satisfactory. Gasoline is expensive, but other fuel is more costly.

Ordinary laborers are paid from 85 cents to $1.00 gold per day; engineers, $1.25; and foremen, $1.50; for 9 hours work. While the men are steady, faithful workers, their efficiency is said not to be equal to that of miners in the United States. However, American miners taken to this region are said to find it difficult to work with the same briskness that they do in the United States.

The graphite is hauled from the mine to La Colorado by mule teams composed of from 10 to 14 mules. The mules do not look much larger than St. Bernard dogs, and actually do not weigh over 500 to 600 pounds each, but are extremely tough and hardy and can do much more work than would be supposed by one used to the larger animals of more temperate climes. In Figure 8 the perspective, unluckily, gives no adequate idea of the size of the animals, but by comparing them with the wagon to which they are hitched their diminutive size becomes apparent.

FIG. 8. A MULE TEAM AT LA COLORADO, SUCH AS IS USED FOR HAULING GRAPHITE.

The securing of a sufficient supply of water for the use of the mine, laborers, and stock has been one of the difficulties to be overcome. Wells have been sunk in the granite at several points within half a mile of the headquarters house and water is pumped to a tank by gasoline engines. The miners' families are allowed 10 gallons per

FIG. 9. MINERS' FAMILIES GETTING THEIR DAY'S RATIONS OF WATER.

day for each family, and this is doled out each morning to the boys and women, who carry it away in 5-gallon kerosene cans.

The graphite from the Santa Maria mines is shipped to Saginaw, Mich., for treatment, where it is ground and separated by means of air flotation and bolting. Some of the best pencils in the world, such as the Koh-i-noor, made by the Hardtmuths in Austria, and nearly, if not all, of the better American pencils, are made from it. The pencil trade, however, while taking the very finest grades of amorphous graphite, does not use a great quantity. The coating of gunpowder takes other small quantities of good graphite. Much the larger use is in the manufacture of lubricants, for which purpose the graphite must be very pure and free from grit, and the product of these mines has met with great success in this field. For foundry facings, the poorer grades may be used and are ground with talc. The poorer grades are also used for paint and stove-polish.

THE BRIDGES OF NEW YORK CITY.

By T. Kennard Thomson.

II. BROOKLYN BRIDGE, AND BROOKLYN BRIDGES.

In a preceding article Mr. Thomson commented upon the principal bridges crossing the Harlem River, and the more important bridges generally of the boroughs of Manhattan and the Bronx. In this concluding installment he treats of the East River bridges and the smaller structures in the boroughs of Brooklyn, Queens, and Richmond.—THE EDITORS.

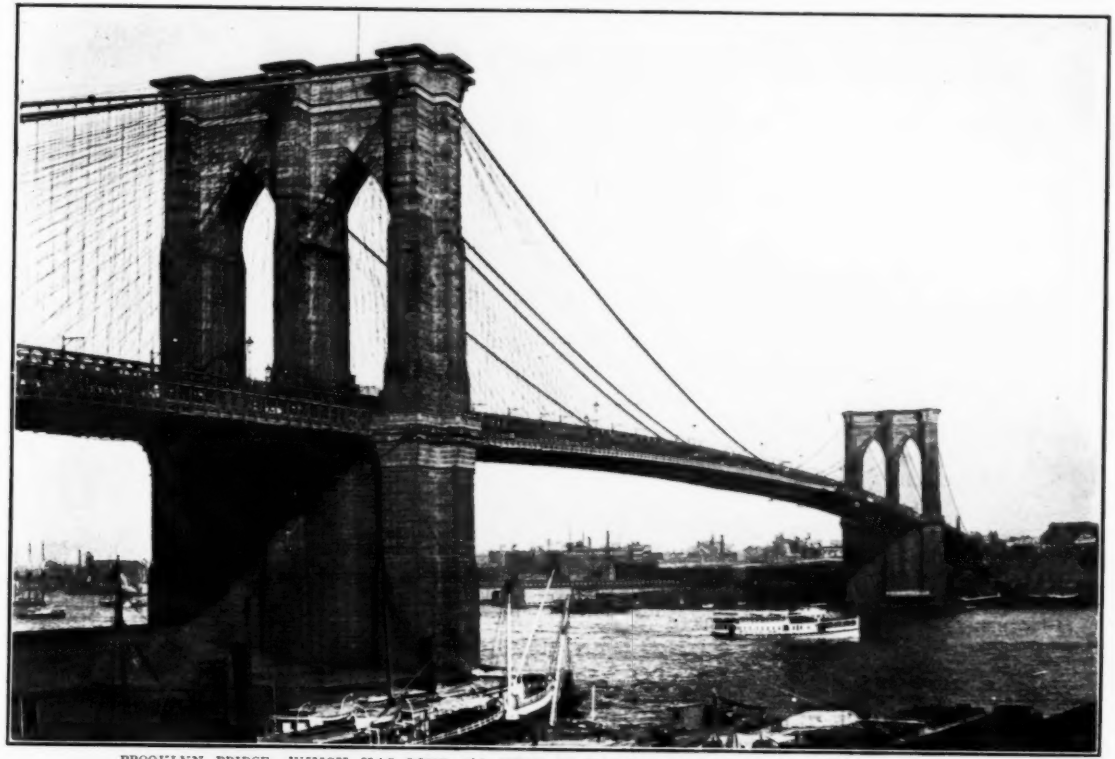
THE first bridge across the East River fittingly connects the city halls of New York and Brooklyn. It was completed by John A. Roebling in 1883 and long held the record of being the greatest birdge in the world, having a river span only 5 feet short of 1,600 feet, the length of the second, or Williamsburg Bridge. The total length of the Brooklyn Bridge is about 6,000 feet and the cost was $11,000,000. This structure has not only done all that its designers intended it should, but has long carried much heavier loads than were ever anticipated by its builders.

The fine-looking masonry towers are 272 feet high and will probably never be duplicated, as the tendency now is toward steel towers.

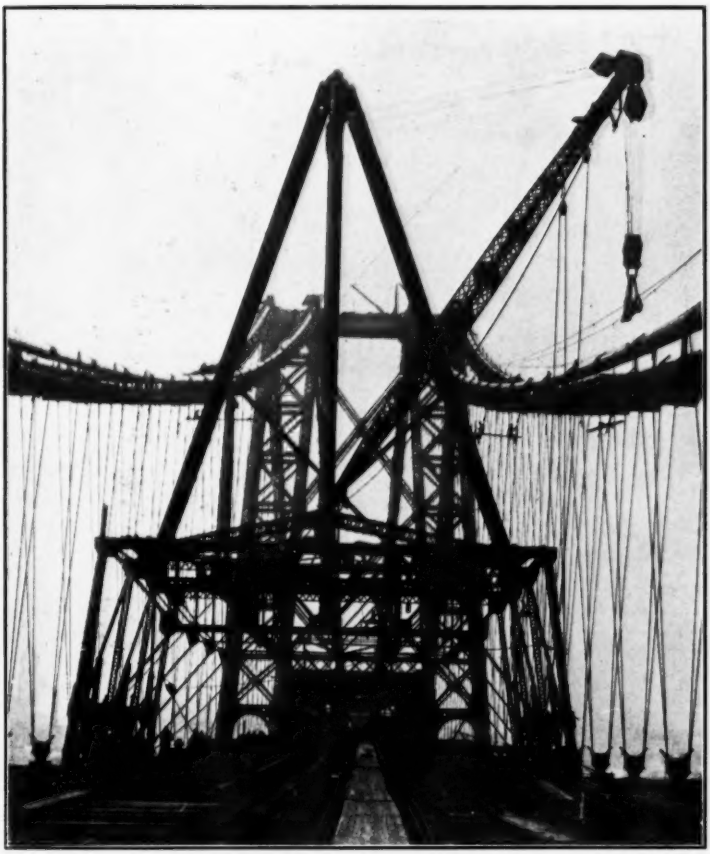
As the old bridge is only 85 feet wide and we all know that it cannot handle the traffic that wants to cross over it, although 300,000 people use it daily, a new bridge should be started at once as near to it as possible, but having about three times its capacity.

People nowadays hardly realize all the problems that Roebling, also of Niagara River fame, had to solve when he designed the Brooklyn Bridge; in fact, the strain practically killed him in the end. To mention one of the simpler of the problems that had to be considered: we know that the center of the river span rises and falls probably more than 9 feet each way, partly due to the loading and partly to the temperature changes. The maximum deflection of the Williamsburg Bridge, a much more rigid structure, is only 6 feet 9 inches.

In 1898, the Brooklyn Bridge was leased to the Brooklyn Elevated Railroad in June, the trolley cars having commenced running over the bridge in February of the same year.



BROOKLYN BRIDGE—WHICH HAS DONE ALL THAT IT WAS DESIGNED TO DO, AND VERY MUCH MORE.



WILLIAMSBURG BRIDGE UNDER CONSTRUCTION.
Showing the traveler.

Williamsburg Bridge.

This, the most rigid long-span suspension bridge ever built, has stiffening trusses about 40 feet deep, or nearly two and a half times the depth of the stiffening trusses of the old Brooklyn Bridge. The main span is 1,596 feet and the total length of bridge is 7,250 feet, nearly one and a half miles. Williamsburg Bridge is 33 feet wider than the old Brooklyn Bridge. It cost about $10,000,000, exclusive of real estate, and was completed in 1903, all except the connections with the elevated lines.

WILLIAMSBURG BRIDGE, OR EAST RIVER BRIDGE NO. 2.

The Williamsburg Bridge, or Bridge No. 2, as it was first called, crosses the East River from Delancey and Clinton Streets, in Manhattan, to Driggs Avenue, near Broadway, in Brooklyn.

The four main cables are each made up of 37 strands and each strand contains 208 wires, making 7,696 wires in each cable, or 31,784 wires in the four main cables, making nearly 18,000 miles of wire. And, as we have said, these cables stretch enough, owing to expansion and contraction, as well as to the effect of the live load on the bridge, to allow the center of the bridge to deflect 6 feet and 9 inches, and yet this is a very rigid suspension bridge.

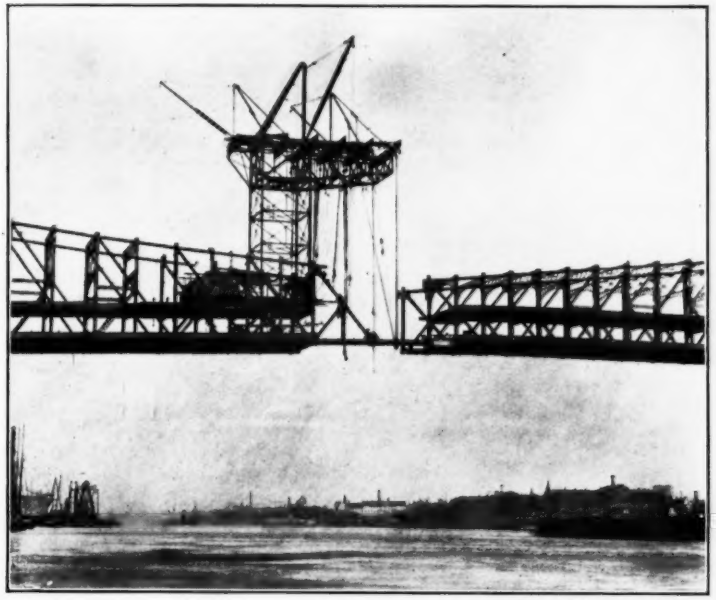
Manhattan Bridge.

East River Bridge No. 3 is near the old Brooklyn Bridge on the north side, the Brooklyn ends being quite close together, while the Manhattan end of Bridge No. 3 is at the Bowery and Canal Street. This is to be the widest (120 feet) of the East River Bridges so far started. It will cost about $12,000,000, and will have a river span of 1,470 feet, or about 125 feet shorter than the other two East River suspension bridges. The total length will be about 7,000 feet.

The steel towers on which the cables have been erected are of unique construction, for while, as we have seen, the old bridge is on stone towers and the Williamsburg Bridge has massive square steel towers (that is, each tower has four legs of steel well braced together—the usual construction) the Manhattan Bridge will have steel towers of only two legs braced together, so if one looks at the bridge from the side it would look as if the cables were supported by a single post 322 feet high on each side of the river. We know that there is a very considerable movement of the top of the towers of these suspension bridges, owing to the contraction and expansion of the cables, etc., and that masonry is not adapted to taking care of the enormous bending strains thus produced, and it was thought that by making towers of two legs instead of four the towers would sway more easily without inducing such severe bending strains.

This is the bridge that caused such a hot fight some years ago over the design, a fight which caused a delay of several years in the construction of the bridge, on the question of using steel eye-bars instead of wire cables. While the eye-bar plan of Mr. Lindenthal was rejected after he had retired as bridge commissioner, many eminent engineers indorsed his plan.

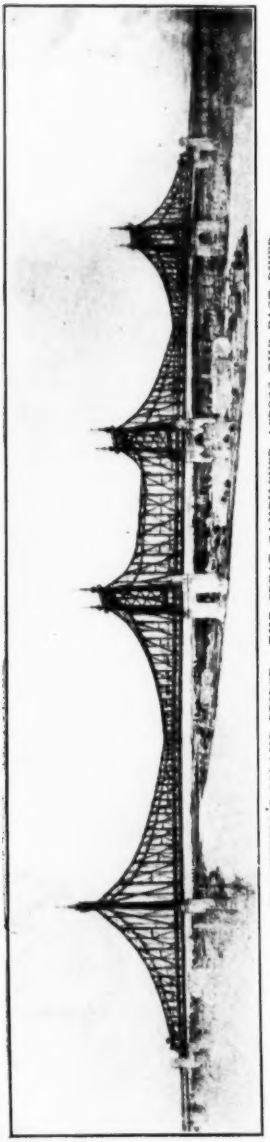
MANHATTAN BRIDGE, SEEN FROM THE APPROACH TO THE BROOKLYN BRIDGE.



CLOSING THE GAP IN THE CENTER OF THE BLACKWELL'S ISLAND BRIDGE.

Work was started on the foundations in 1902, and the bridge will probably be completed in 1910. The wires in the cables of this bridge, if stretched out in a single line, would make a line some 23,000 miles long, or nearly enough to girdle the world. The depth of the stiffening truss is only 24 feet, as against 40 feet of the Williamsburg Bridge and 16 feet of the old Brooklyn Bridge.

The four cables are 21¼ inches in diameter and have a dip of about 148 feet below the saddles. The length of the cables between eye-bar anchorages is 3,223 feet, and each cable is made up of 9,472 parallel straight wires about 3/16 of an inch in diameter, having an ultimate strength of about 6,000 pounds each, or over 200,000 pounds per square inch, after galvanizing. The wires were made in 3,000-feet lengths and spliced together with sleeve nuts at the mills, making continuous lengths of 80,000 feet. The wires were shipped on 4-foot reels about 4 tons, having been first galvanized by being immersed in molten zinc. At the ends, the wires were divided into 37 strands of 3½ inches in diameter, containing 256 wires each.



BLACKWELL'S ISLAND BRIDGE. THE GREAT CANTILEVER ACROSS THE EAST RIVER.

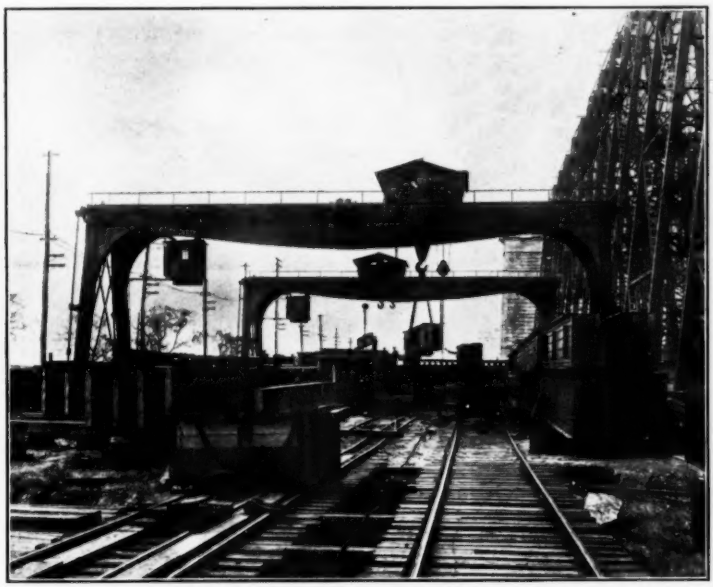
The wires were drawn over the river by a ¾-inch steel cable which passed around a 6-foot sheave at each anchorage. It usually took about 7 minutes to haul a wire from one anchorage to the other, and as many as 812 wires were laid in a single day. The hauling apparatus was very simple, being a 50-kilowatt Crocker-Wheeler motor geared to a horizontal shaft with a 12-tooth bevel pinion engaging a 60-tooth horizontal gear wheel keyed to a short vertical shaft with a 6-foot wood-lined traction wheel. Many ingenious devices were used to keep the wires in place, splice them when necessary, and make the adjustments so that each wire would carry its share of the load—a very difficult but important matter.

The Carbon Steel Company sublet the erection to the Glyndon Contracting Company, who made the record for rapid erection of a long-span suspension bridge, a proceeding which was watched with interest last summer by all those whose office windows faced the bridge.

Blackwell's Island Bridge.

Blackwell's Island Bridge, or East River Bridge No. 4, now crosses the East River opposite 59th Street, New York City, and has the longest cantilever spans in America—1,182 feet over the West Channel and 942 feet over the East Channel, with a shorter continuous girder span over the Island. It will probably hold the record until the new Quebec Bridge with its 1,800 feet span is completed. The total length of the Blackwell's Island Bridge is about 3,720 feet, with a width of 88 feet. Like all

the other East River bridges, it will be double-decked, having a 36-foot roadway and four trolley tracks on the first level, with two railroad tracks and two foot-walks on the upper deck.

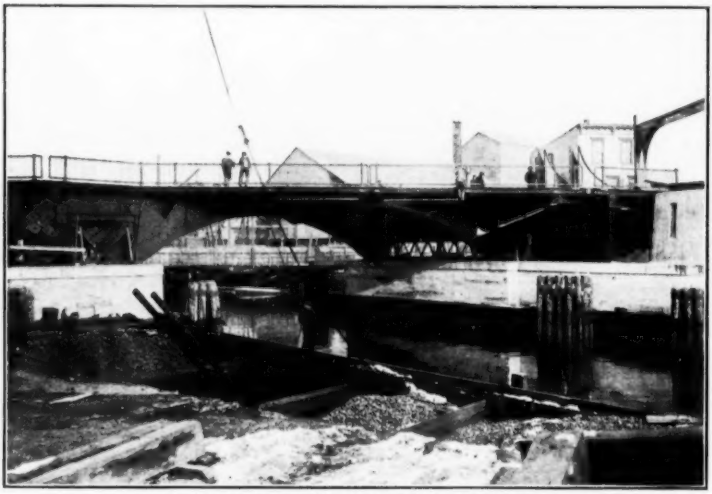


BLACKWELL'S ISLAND BRIDGE, SHOWING YARD, MATERIAL, AND TWO LARGE GANTRY CRANES.

This bridge cost about $20,000,000 with approaches and real estate, and is expected to connect with a cross-town subway under 59th Street. The short span rises 328 feet above the Island over the piers, as in all the other East River bridges; the U. S. Government insisting upon a minimum clear height for ships of 135 feet for the two channel spans.

This bridge is five blocks south of the bridge the late Austin Corbin started to build in 1895 in connection with the Long Island Railroad, which he then controlled. After building two piers, one on each side of the Island, above the high water line, work was stopped on account of the financial market, and, owing to the death of Mr. Corbin, never resumed, although several hundred thousand dollars had been spent. The charter was obtained by Dr. Rainey, who spent a great many years of his life trying to

get this bridge built, and spent much time trying to get the city to finish his bridge instead of starting fresh at 59th Street; the city wanted a wider bridge, but did not get so good a location nor so good a bridge, although paying more. Work was started on the foundation of the city bridge in 1901.



HAMILTON AVENUE LIFT BRIDGE, BROOKLYN.

Nearly all cantilever bridges have what is called an anchor or shore-arm from each river pier and a cantilever-arm from each of these piers, projecting out over the river, and as these cantilever-arms are usually only a little over one-quarter the length of the span between the two shore piers, we still have a space equal to nearly half the span to be bridged, which is usually accomplished by what is called a suspension span, an independent bridge resting on the ends of the two cantilevers as if they were piers. During erection the suspended span is built as a continuation of the cantilevers, but after the erection is completed it is partially disconnected so as to rest on the cantilever arms as an independent bridge. The two principal objects of the suspended-span system are economy and prevention of the sudden change of strain from one system to the other, according to the position of the load. But Blackwell's Island Bridge is unique, at least for long spans, in having the cantilever arms meet in the center without any intervening span. It remains to be seen whether this

innovation will be an improvement or the reverse, but it is certainly not economical, nor, in my opinion, so good.

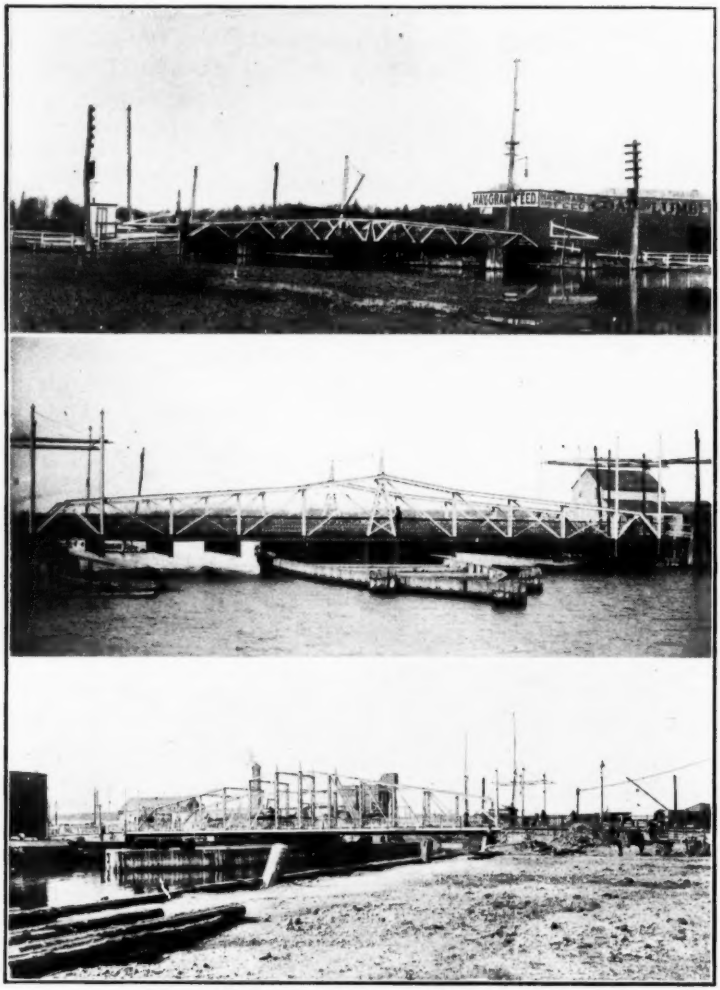
The extreme deflection of the Blackwell's Island Bridge, due to temperature and loading, is expected to be about 20 inches as against nearly 7 feet for Williamsburg and 18 feet or so for the old Brooklyn Bridge.

Newtown-Creek Bridge.

The most important bridge over Newtown Creek is the lift bridge at Vernon Avenue, which cost about $750,000, with a total length of 1,700 feet, having a Scherzer lift span of 150 feet clear, or 172 feet between centers of bearings. This is probably the longest Scherzer lift span built. The bridge is 65 feet wide, has towers 78 feet high, and was opened to traffic on October 17, 1905. This form of bridge jack knife is so arranged that instead of swinging around it swings up, forming two arms which, when lowered, meet in the center of the river, requiring a nicety of adjustment in order that the roadway over the joint shall be level and remain so while the traffic is going over.

VERNON AVENUE LIFT BRIDGE, QUEENS.

These lift bridges have also been used to a large extent in Chicago. As the traffic here is enormous, there was quite a discussion as to whether a lift bridge should be built, or a tunnel which would also have continued under the Long Island Rail-



THREE SWING BRIDGES OF THE BOROUGH OF QUEENS.
Beginning at the top, the bridges are Little Neck, Strong's Causeway, and Metropolitan Ave.

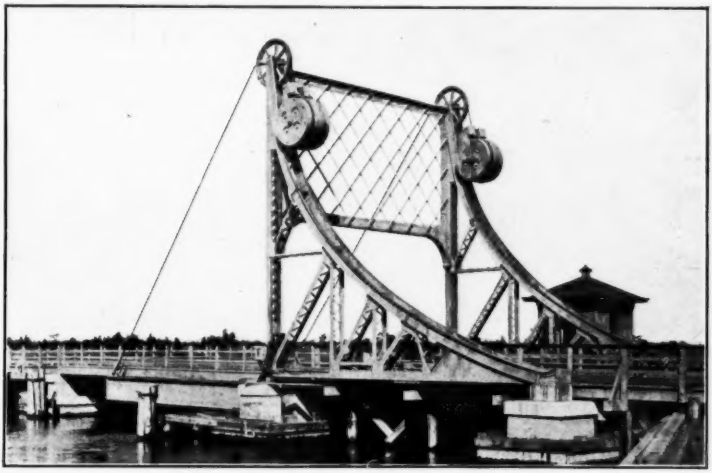
road tracks; the obvious advantages of the tunnel being freedom from interruption to either land or river traffic.

HAMILTON AVENUE BRIDGE.

Another lift bridge is that over Gowanus Canal in Brooklyn, under which vessels carrying 2,000,000 tons per annum pass, al-

though the canal is only 100 feet wide. Each lift of this bridge weighs 175 tons and the total cost was $175,000, which includes raising the grade of Hamilton Avenue about 10 feet at the bridge.

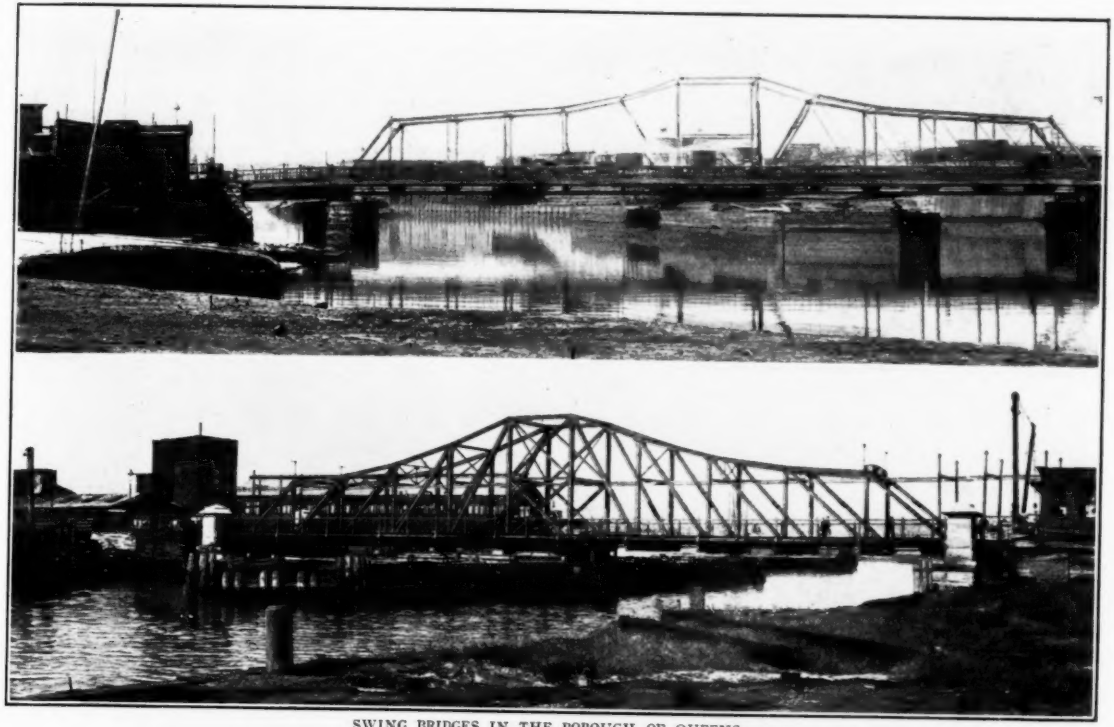
Among the smaller bridges in the Boroughs of Queens and Brooklyn which are very important in their neighborhood, we have the Metropolitan Avenue bridge over Newtown Creek, which was built in 1884 as a center-bearing swing bridge 174 feet long with 20-foot roadway, to replace two bridges a few hundred feet away. Like most bridges built in the Eighties this is out of date and should be replaced by a wider bridge. The abutments were altered so as to allow the bridge to swing through a complete circle of 360 degrees, thus saving much time in operation for both land and river traffic.



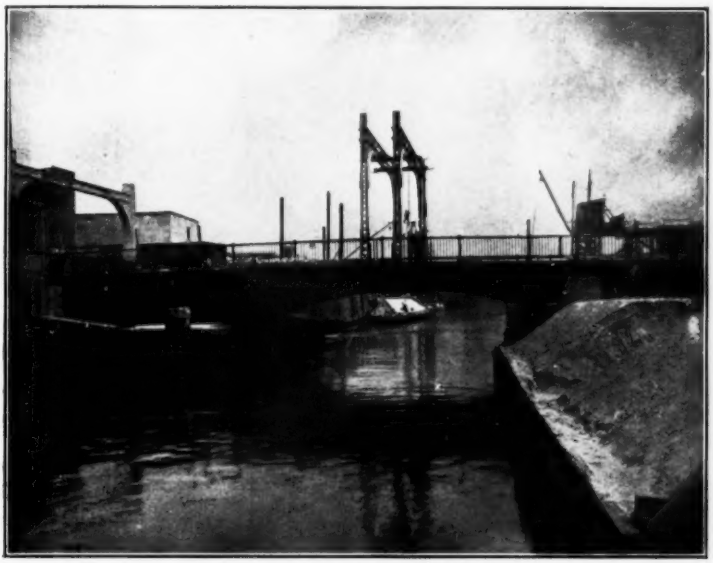
LIFT BRIDGE, HARWAY AVENUE, BROOKLYN.

A smaller and lighter bridge still is the Strong's Causeway bridge in the Borough of Queens—a light, low-level steel swing bridge, with ten panels of the half-through type; that is, with top chords too low for any overhead lateral bracing.

On the same page is shown Little Neck bridge over Alley Creek, Borough of Queens, which is on the main line of traffic on the north shore of Long Island and is considered the third link in a chain of bridges of which Blackwell's Island is first and Flushing Bridge the second. The plate shows also a light steel half-through swing bridge of a still lighter design than Strong's Causeway.



SWING BRIDGES IN THE BOROUGH OF QUEENS.
(Above, Meeker Avenue; below, Greenpoint Avenue).



NINTH STREET BRIDGE, BROOKLYN.

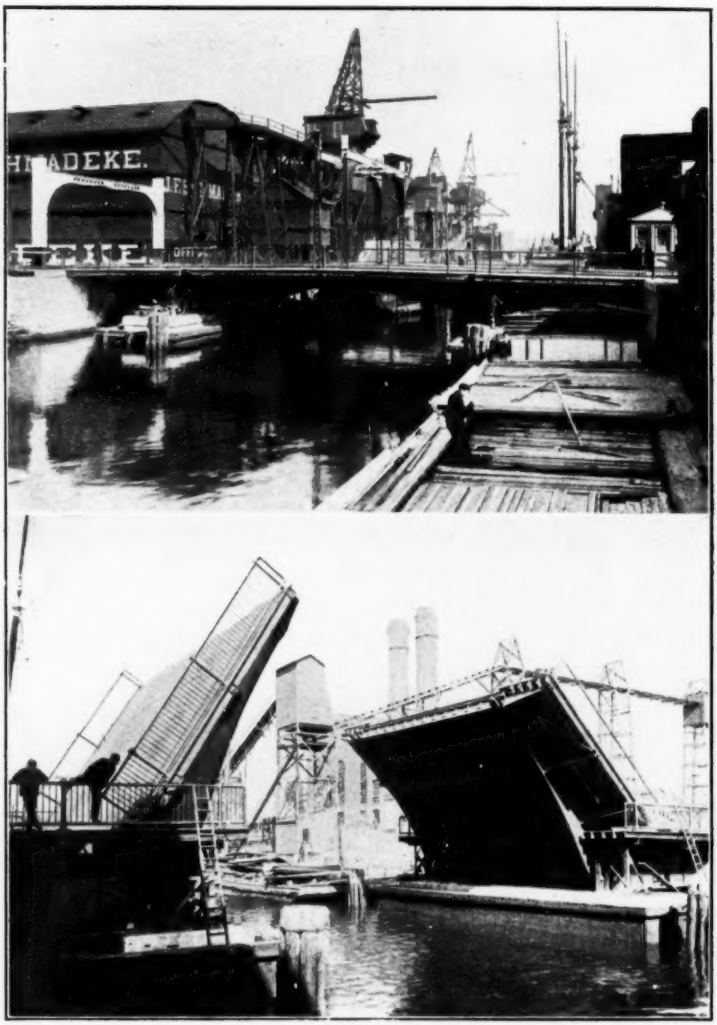
In none of these bridges was any attempt made to obtain any head room when the bridges are closed, so the floor beams are hung below the bottom chords, to avoid raising the floor level.

In the Greenpoint and Meeker Avenue bridges we have good examples of "through" truss swing bridges where the top chords are high enough to permit overhead lateral bracing, making a rigid structure much easier to obtain. While these bridges have more head room than bridges like Strong's Causeway, they still have not enough and should be reconstructed so as to have 24 feet head room, the same as the Vernon Avenue Bridge, and also clear the L. I. R. R. tracks.

NINTH STREET, THIRD STREET, AND UNION STREET BRIDGES.

The old bridge at Ninth Street, over the Gowanus Canal, was a swing with channel of about 32 feet on each side of the pivot pier, being so narrow that the property owners petitioned for a single 50-foot channel.

A unique feature of these three new bridges was the letting of all in one contract on December 30, 1903, to R. H. Hood & Company, making the steel work of all three from the same set of



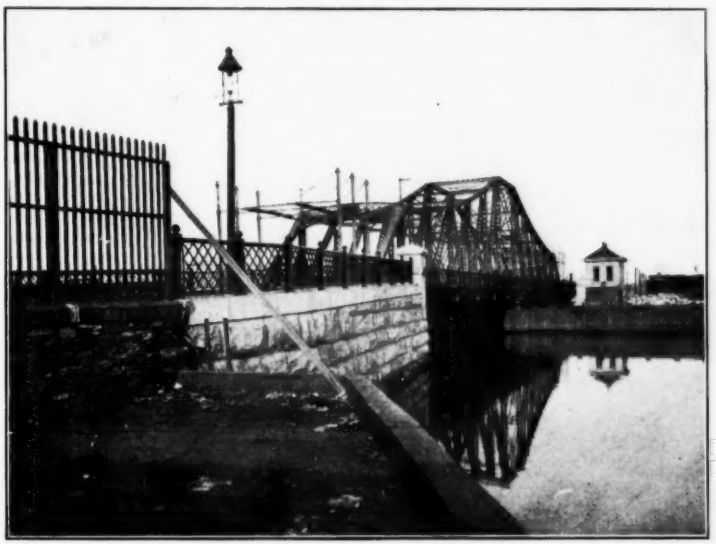
TWO BROOKLYN LIFT BRIDGES.
The upper one is Union Street and the lower, Third Street.

plans, an economy not often encountered in municipal undertakings. These bridges are of the jack-knife or bascule type, or two-leaf Scherzer deck, and are 35 feet wide. The masonry of the old Union Street bridge was found to be exceptionally good and

therefore cost the contractor more time and money than he anticipated for its removal.

The photographs show the Ninth Street and Union Street bridges closed, and that of the Third Street open, both arms being raised to allow the boats to pass.

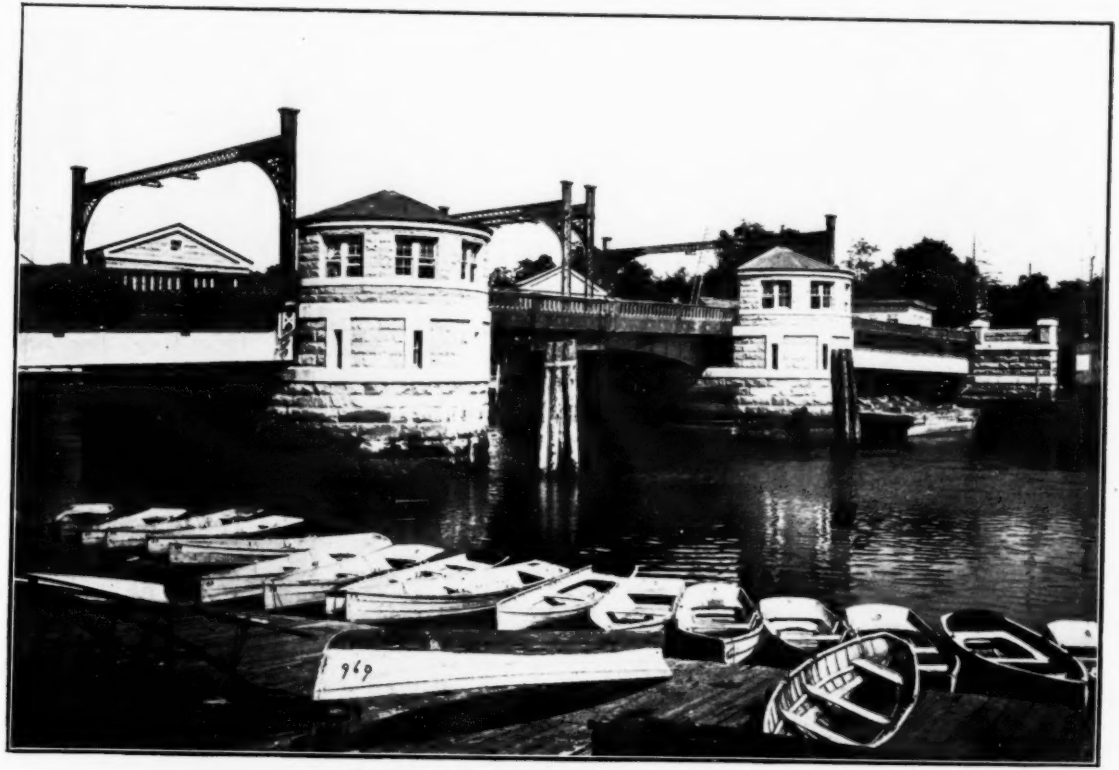
Washington Avenue Bridge, over Wallabout Canal, Brooklyn Borough, was rebuilt in 1893 by the Kings Bridge Company, who put in a plate-girder retractile bridge, 123 feet long, with two roadways 15 feet 6 inches wide. The bridge is operated by electricity, about 3 minutes being required. There is also an electric capstan for towing the boats through—a great time-saver.



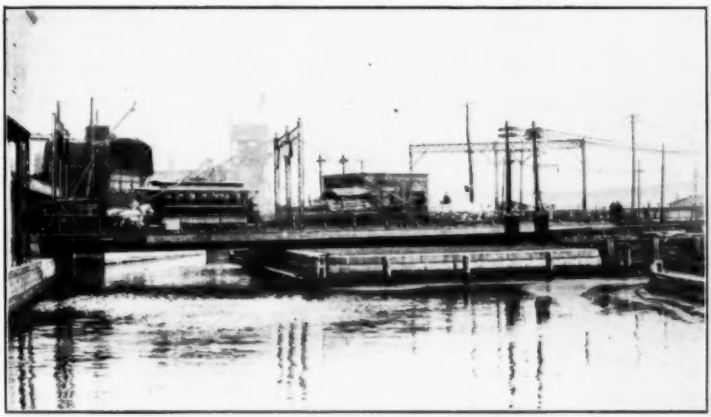
GRAND STREET SWING BRIDGE, QUEENS.

Grand Street Bridge, another of the Newtown Creek bridges, was opened in February, 1903, having been built by Bernard Rolf for about $175,000. It is a fine modern swing bridge, with, however, only 11 feet clear above high water. This is a through truss span and the photograph shows the end portals and top lateral bracing and gives a very good idea of the construction of the trusses.

Carroll Street Bridge, Brooklyn, over the Gowanus Canal, was built in 1889 by the Trenton Iron Works; another plate girder with light truss on top, retractile drawbridge on pile and timber



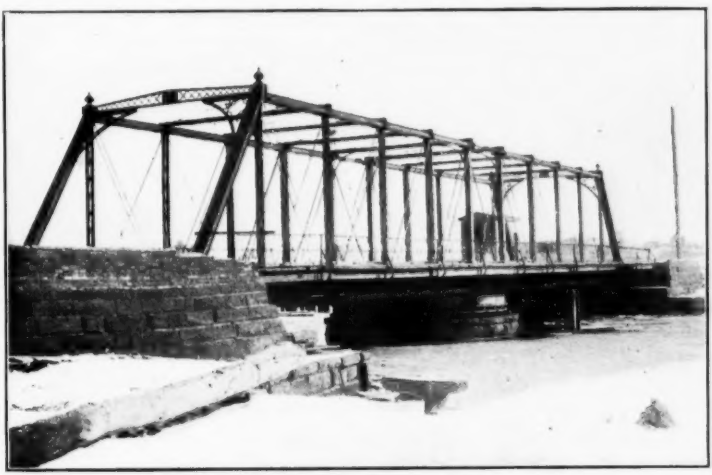
FLUSHING CREEK BRIDGE, BOROUGH OF QUEENS.



WASHINGTON AVENUE DRAWBRIDGE, BROOKLYN.

foundations. It was 104 feet long, with 17 feet roadway and 4-foot sidewalks. It will be noticed that for the sake of a balance the bridge is made long enough for two spans while there is only one channel, one-half of the bridge being always on land. This bridge is operated by steam.

Flushing Bridge, over Flushing Creek, already referred to, was built by Snare & Triest, who in April, 1904, took a contract



HUNTER'S POINT SWING BRIDGE, BOROUGH OF QUEENS.

for $257,844 to replace the old bridge (which was never intended for trolley cars) with this fine ornamental bascule bridge with elaborate watch towers on the ends of the piers. The clumps of pile fenders in front of the bridge do not, however, look very ornamental.

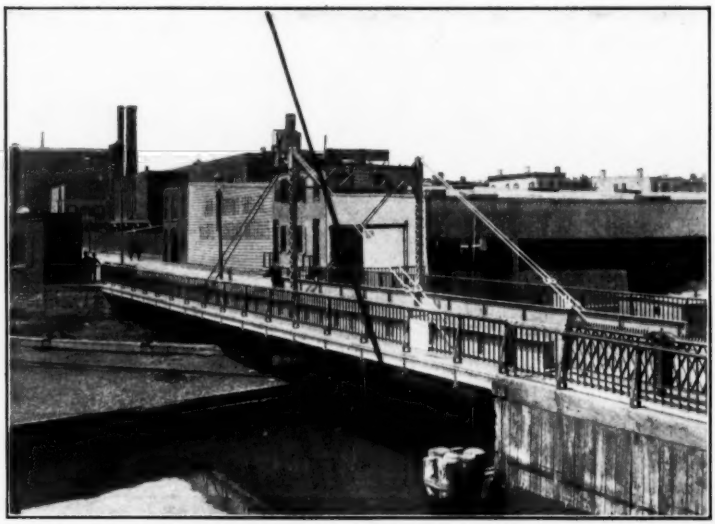
At Hunters Point, Queens, we have another type of a swing bridge with parallel top and bottom chords—a plain enough looking structure. This shows a circular girder or drum transmitting the strain through the rollers or wheel to the pivot pier near its outside circumference instead of having the main weight carried by a single pivot in the center of the pier.

LEMON-CREEK BRIDGE.

At Princess Bay, Borough of Richmond, was a small wooden retractile bridge which opened by rolling back over the roadway at right angles to the stream, being strictly a drawbridge as opposed to a swing bridge, which is often miscalled a drawbridge. One disadvantage of a rolling bridge is that, if the opening is, say, 100 feet, it has to roll back on the street at least 100 feet, thus blocking that much space.

HARWAY AVENUE BRIDGE.

Over Coney Island Creek is a plate-girder bascule bridge with counterweights rolling on vertically curved tracks. The lift span



CARROLL STREET BRIDGE, BROOKLYN. A SWING BRIDGE WITH BUT ONE CHANNEL OPENING.

LEMON CREEK BRIDGE, BOROUGH OF RICHMOND.
Of later construction than the bridge mentioned on page 68.

is 50 feet long and is raised by two 5-horse-power motors with 220-volt current. This bridge was built about ten years ago. It is shown in the illustration on page 61.

The Elevated structures of New York are too well (?) known to need any description. As most of them were poorly and lightly designed in the first place, a great deal of money has been spent stiffening them up to make them safe, which reminds us of when a reporter went to Russell Sage about the rumor that the "Elevated" was not safe, as rivet heads were at that time continually being sheared off and dropped to the ground, Mr. Sage remarked that the rumors were absurd and that his railroad was absolutely safe, and then added, by way of proof: "Why, our chief engineer stays awake most of the nights worrying about it." Much good work has been done strengthening the weak points since then, so that it is now in a pretty safe condition, in many places the structure being twice as strong as it originally was.

The Bridge Department of New York City is also fortunate in obtaining so many high-grade engineers, of whom Mr. Kingsley L. Martin is the chief, with Messrs. Alexander Johnson and Austin Lord Bowman as consulting engineers.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS

By Charles Day.

Mr. Day's articles—or, more specifically, the first of the series published last month, and this second, now presented—are based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use that the series has been completed, at the invitation of THE ENGINEERING MAGAZINE, for wider presentation. As here presented, the original matter is revised, adapted, and very largely extended to cover the later phases of construction and occupancy.—THE EDITORS.

I STATED in the preceding article that the subject would be considered generally, without reference to any specific line of business, and presented a classification covering the entire work incident to the planning and building of industrial plants. The main headings of this classification are repeated below for the purpose of reference:

P—Preliminary Service (Definition of requirements).

F—Financing.

D—Detail plans and specifications.

C—Construction and installation of equipment.

M—Period of occupation and commencement of operation.

Attention was called to the fact that new plants are usually provided either as additions to existing properties, or to house businesses formerly conducted elsewhere, and the causes which have resulted in the more general employment of engineering organizations were enumerated. This is reiterated because the plan of procedure for the preliminary work is based upon these premises.

Sub-divisions P-a to P-d inclusive have already been treated, and this paper will be devoted to the remaining sub-divisions of the preliminary work.

Sub-divisions P-a and P-b referred to the compilation of data relating to specific manufacturing requirements, both present and future, and concerning such fundamental principles of shop administration as have any material bearing upon the selection and arrangement of machinery and building features. Sub-division P-c related to the advantages accruing through the study of plants recently built for essentially the same class of work as may be at issue, and particular attention was called to the resources which competent engi-

neering organizations have available for this purpose. Sub-division P-d, which was the last one considered in the previous article, had to do with the determination of the kind and amount of machinery that should be provided for, as well as the requirements of the special or process work imposed by the business.

The results of this investigation should be carefully tabulated, and time can be greatly economized and more complete data secured through the use of standard forms drawn up for the purpose. Much of this body of data is fixed in character; for example, the weights and dimensions of the largest articles that are handled directly govern the floor loads, overhead room, door openings, and crane requirements that should be provided for in the building designs, whereas such unit figures as the floor space per operator in different departments, or the handling cost per unit of output, or the current consumption for artificial lighting per square foot of floor area, frequently show the necessity for modification prior to their adoption as a basis for the work that follows.

Then, again, a study of certain of these statistics will often result in the discovery of inefficient performances in specific operations, and means for their correction can be provided in the new layout. The analysis of certain cost data, particularly those which have to do with the handling of materials or partially finished articles, is important, as the economies which should follow the provision of facilities other than those in use can be ascertained only with such information at hand.

With this *résumé*, I will proceed with the consideration of the next sub-division of the preliminary work.

P-e. Decide upon geographical location of site and whether plant should be built in business centre or suburban section.

Additions to existing plants as a rule are provided either upon property already owned, or on an adjoining site that can be acquired. At times, however, it is decided to build an entirely new plant and complete freedom of choice may be permissible. If this is the case, after the engineer has proceeded as far as I have gone, he can intelligently discuss with the owner the question of geographical location. The governing factors are usually the raw-material market, the logical point for the distribution of sales, the labor market, and certain broad matters of business policy. I will not elaborate these factors further than to say that it must be borne in mind that certain businesses will show a good profit only if investment charges are curtailed to a minimum through the purchase of an inexpensive site and the adoption of buildings of the utmost simplicity; whereas in other cases

much more permanent and ornate structures, located directly in a business centre, may be permissible or even desirable on account of the economic and publicity advantages gained through intimate contact with the market. The character of competing plants must always be taken into account, as sales prices are governed largely by rates at which other companies can market their goods at a profit and these rates are dependent partially upon the investment charges.

Usually a number of locations are taken under consideration and final judgment is deferred until the negotiations for a specific property can be undertaken.

P-f. Decide preliminarily upon the sequence and general arrangement of equipment and processes, based upon elemental routing and administration requirements.

The character of the locality in which the plant is to be built has a very decided influence upon the layout of departments and the character of the buildings, as it largely governs the necessity of multiple-story structures. Since a decision has been reached in this regard, the work can proceed with the arrangement of the machinery and processes that have been selected previously for the performance of the industrial work. In the first instance, this matter should be considered wholly aside from any preconceived opinions (other than those of the broadest character) regarding building types. Usually the industrial engineer can assist very materially in this work, as the arrangement of machinery and the inter-relationship of departments are governed by broad principles which are common to industrial work of all kinds. A theoretical arrangement of machinery should first be made, with a view to minimizing the travel of the parts or materials upon which work is to be done when passing from the state in which they are received to a point where they are finished and ready for assembling and shipment.

The most satisfactory method to follow is to make accurate templets of the various machines or the spaces required for manufacturing or process work. In the first instance the outline of each templet should indicate the over-all dimensions of the machine or piece of apparatus, and if these are greater than the foundation dimensions, the latter should be indicated by lines drawn within the limits of the templet itself. Consideration must be given, as suggested above, to the necessary working space about each machine. The main relationships of various templets are dictated by the conclusions that have already been reached concerning the general plan of manufacture that is to be adopted, but usually a number of alternate layouts differing in detail will suggest themselves.

In certain cases the routing problem is comparatively simple and dictated requirements can be very satisfactorily met. The arrangement of machinery in a factory for the manufacture of Derby hats illustrates this condition. The raw material consists principally of rabbit fur, which, after being properly cleaned, is passed through a machine called a "former." The conically shaped product resulting is then passed through some thirty processes that gradually mold these cones until they only require the addition of trimmings to make them complete hats. It will be seen that the hats comprise essentially but one piece at an early stage of the process, and the path that they follow can be readily plotted in a manner that will comply with the requirements of minimum handling. This condition also lends itself to the ready satisfaction of a fundamental principle underlying the management of men—namely, that they should ever feel the pressure of work yet to be done and their inability quite to meet the demand ahead of them. This is brought about through the fact that the partially finished hats are passed from process to process in specially designed racks, and as the operators can plainly see the product they have to draw on, an incentive can readily be created whereby each man tries to get done with the work behind him and overload the next operator. The visual evidence as to the conditions of work is ever present.

In comparison with the illustration just cited, I will direct attention to the routing problem that presents itself in laying out a plant for the manufacture of automobiles. Several thousand parts enter into a completed touring car. Many of these require the same classes of equipment for their manufacture, and it is not possible to arrive at machinery and department layouts that do more than meet with a fair degree of efficiency the broad requirements presented by the production as a whole. The routing of individual pieces in many cases will prove very unsatisfactory, but such sacrifice must be made in order to arrive at the best compromise. I wish to dwell particularly on this word "compromise"—the term which must be applied to so many industrial-engineering conclusions. As a rule, there are such a multitude of factors to be taken into account that it is only possible to arrive at a solution which will meet each of the individual requirements in a partially satisfactory way, although the result as a whole may be substantially the best that can be obtained.

The engineer who is well versed in the work incident to the arrangement of equipment and departments in industrial plants realizes to how small an extent he can rely upon any established rules or data and his initiative and common sense must be counted upon to

bring a working result from a mass of what often appear to be conflicting conditions where no logical relation can be traced.

P-g. Determine floor areas required for manufacturing departments, storage departments, assembling departments, offices, etc.; also for likely future requirements.

Having arrived at the arrangement of machinery and apparatus required for process or other special work that will result in a minimum charge for handling of product, it is necessary to decide upon the space that must be provided around each machine or process for the storage of partially finished product.

When the product passes automatically from machine to machine, it is impossible for congestion to occur, so this question is easily solved; but in a majority of cases the performance of a specific manufacturing operation upon available pieces is only indirectly dependent upon machinery other than that required for the purpose of the operation in question. That is, the work is not continuous; there will be certain pieces or materials upon which work is yet to be done, others that are completed in so far as the machine in question is concerned, but that must be stored pending the time when they will be removed to the next operation. When calculating the space required for this storage it is necessary to determine the best method of stacking the product; that is, whether it should be piled on the floor adjoining the machine, or in boxes or special appliances designed for the purpose; also whether the material in question can be moved by hand or must be handled with power. After approximating the area required for machines and storage of parts during transit, the areas needed for passages, general storage departments, special enclosures (such as inspection and tool rooms) must be calculated.

P-h. Determine which departments *must* be accommodated on the ground level and which *may* go on upper floors.

We have settled, so far, only the sequence and general arrangement of machinery and processes and an allotment of space considered as a whole, but no decision has been reached concerning the definite manner in which the area should be housed. It is always desirable to perform certain kinds of work upon a first floor; for example, where the machinery is very heavy and must be supported upon substantial foundations, or where a large amount of overhead room is required for crane service, or where certain process work makes it desirable to have direct overhead ventilation, as may be the case where large furnaces are installed. This, however, cannot be settled wholly from the standpoint of manufacturing requirements.

It has been mentioned that the value of the real estate must be considered, and if this is excessive it may be necessary or at least desirable to put on second or third floors departments which, under other conditions, would be kept on the ground level. Therefore, it is necessary to estimate the cost of the real estate, but this can be done with reasonable accuracy as decision has already been reached as to the probable geographical location and character of locality desired. The results of this part of the work largely govern decision as to building types and construction details.

P-i. Determine railroad and trucking facilities that should be available for receipt and shipment of materials.

The necessary railroad or trucking facilities, or both, required in connection with the receipt of product entering into manufacture and for the shipment of finished goods, have already been preliminarily considered; but these matters must now be taken up in detail, for they have a decided bearing upon the selection of the building site. The desirability of having direct communication with more than one trunk line, the permissible radii of curves, the length of track required and the number of sidings into which it should be divided in order to curtail demurrage and otherwise to facilitate the operation of the work must, therefore, be ascertained.

P-j. Determine total property area needed at once and amount that should be reserved for the future.

A tabulation should now be made of the areas necessary for different classes of work, for storage, and for all other purposes including yard requirements, the immediate and future needs being segregated. The open and enclosed areas should be totaled separately, and a note made of the enclosed floor space that does not necessarily have to be upon the ground floor. With all the foregoing data at hand, a fair opinion can be reached concerning the shape of property that should prove most desirable.

P-k. Select property that most nearly meets the requirements dictated by study of the foregoing factors. If possible, it is preferable to defer purchase until completion of preliminary work.

The considerations have so far been based upon the assumption that an ideal property can be had; and this is as it should be, for the site should be selected with a view to complying as nearly as possible to such an arrangement. Of course, the procedure is somewhat different if the location of the new plant is fixed in advance, as actual conditions must then be taken into account from the start with a view to minimizing apparent disadvantages.

Usually a number of sites are found to possess certain of the essential requisites, although each may fail to comply in some particular with the ascertained requirements. Consequently, several properties are frequently taken under consideration pending the completion of definite layouts, building sketches, and estimates of total cost.

In order to make the best selection of property for an industrial plant, all the data bearing directly upon the desirability of the location for the business in question should be separately tabulated, and in this way the work will be greatly simplified through the ready elimination of undesirable sites. The essential data will in most cases comprise a knowledge of the character of soil for foundation purposes, expense that will be incurred to make the property available, cost of property, availability of water, coal, oil, gas or other raw materials, sewers, and protection afforded by the locality against destructive fires, etc. I have assumed that the decision previously reached as to geographical location has been based upon a knowledge as to the desirability of the labor market, and the point best suited for the economical receipt of the materials or products upon which work is to be done and their final distribution to customers, and, of course, only such properties would be considered as afforded the requisite area.

If one property appears to be undoubtedly preferable to all others, the engineer can then proceed accordingly; but as has been stated, it is possible that he may wish to work up preliminary layouts for several properties before making the final selection. In this case, precise information should be secured concerning each site that is to be taken under serious consideration. First a survey should be made, preferably by engineers in the employ of the municipality or county in which the site is located, for their intimate acquaintance with the status of local surveys, deeds, and records is valuable. The "plat," as a survey is called, should give the property limits and elevations (at the intersection of suitable cross-section lines) which should preferably refer to established datum. The location and character of all buildings, or other structures, and railroad sidings existing on the property, should be carefully recorded, as well as conditions of this character in connection with the abutting properties. All sewers, gas pipes, water pipes and openings to same, as well as electric circuits (both overhead and underground) occupying the adjoining streets or crossing the property, should be indicated and their depth or height above the standard datum noted. The same plat should indicate the location of such test pits as are made in order to determine

the character of the soil or wells that have been driven to ascertain the available water supply, and a note should be included calling attention to adjoining streams, if any exist, and to the nearest trolley system or railroad, if sidings are not available upon the property. Frequently, much of this information cannot be recorded upon the plat itself; but, in such cases, reference should be made to the source where it can be had. The engineer's work is greatly facilitated if thorough information in regard to the matter just touched upon is promptly secured and properly recorded.

P-I. Prepare alternate layouts of departments, segregating them into one or more buildings of assumed types, taking into account all the foregoing factors including the selected property.

We are now in a position to decide to how great an extent the different departments should be individually housed or shut off from each other; that is, how the total floor area should be divided between separate buildings and the given buildings into distinct units.

Obviously, it would be inconsistent to have a saw mill in the same room or enclosure with departments for shellacking and final finishing of wood surfaces, as good work of this character cannot be performed where the surrounding air is carrying even a small amount of dirt or grit. For the same reason, a gray-iron foundry should be separated from a machine shop in which delicate or accurate work must be done.

In contrast to the illustrations just cited, there are many other instances where it is much more difficult to decide whether or not the departments should be separately housed.

In certain localities it is not feasible to have union and non-union men working side-by-side in the same shop unless their work falls under widely separate heads. This is occasioned by the fact that at times union men positively refuse to work when non-union men are engaged in their midst. Many types of machinery, however, can be properly and economically operated by comparatively unskilled labor, but to permit this it becomes necessary to meet the limitations imposed by the labor unions by housing such equipment in separate buildings.

It must ever be borne in mind that in connection with all, or practically all, the matters that we are discussing there is a very great deal of room for difference of opinion among those who are working together, so that it is always necessary for the engineer to have a good and sufficient reason to support each of his recommendations; and in many cases, after the problem has been discussed between client and engineer, a modified plan is adopted, emphasizing again

the need of complete co-operation upon the part of all interested in a project of this character.

We have now reached the point where preliminary sketches can be made of the buildings, and if all the information covered by the foregoing headings has been systematically tabulated, this resolves itself into a comparatively simple matter. The information in question dictates, as it were, the places where the building structure must not trespass, so that the design of a building to conform with all the industrial requirements means that the result must be such that the work to be performed can go forward with practically as much freedom as though the building did not exist at all; that is, the workers, whether employed at individual machines or engaged in moving material from point to point, should, to all intents and purposes, be unconscious of the existence of the housing structure. If this is not the case, the buildings become a constant hindrance to the efficient performance of the industrial work, which will be evidenced through inefficient departmental arrangements and the existence of structural details that interfere with the most economical manufacturing performance.

Possibly a crude illustration will serve to emphasize this point. We will assume that it has been decided to build an enclosed oval track for bicycle races, and that those who are behind the proposition, being familiar with the proper plan to follow, engage a party who makes a specialty of the building of race tracks proper. We will compare the result that should be secured in this case with what would probably follow had they first employed an architect to design the building in which a track was to be built. In the first instance, after carefully selecting the site, the race track would be built in the open, and the only consideration would be to provide an oval that from every standpoint would lend itself to the attainment of the highest racing speed with the greatest degree of safety. After the accomplishment of this end, it would be a comparatively simple matter to design a building that would completely house the track without interfering in the slightest way with the performance of the riders. In the second instance, while the requirements of a high-speed race track would no doubt be taken into account to a certain extent by the architect, it is more than likely that after the work was completed certain difficulties would develop. For example, it might be found that the track could not be banked at the corners quite as much as it should be, owing to the fact that a row of side windows of a continuous height around the building prevented such a course. Again, the widening of the track at the curves might be interfered

with through the location of one or more columns that had been placed without knowledge of the fine points of race-track requirements, such as the plan used by contestants for passing each other at the curves. Just as the governing factor in the solution of the illustration just cited is simply a routing proposition, so it is also of great importance in regard to the determination of the character and sizes of buildings for industrial purposes; but this, of course, does not apply to the selection of building types—that is, the kind of structure that should be adopted.

The decision whether the buildings should be of reinforced concrete, or of mill construction, or steel-frame, rests in part upon the specific requirements dictated by the manufacturing work that is to be performed within them and upon certain requirements incidental to this work, such as climatic conditions, provision for protection against fire, the character of locality in which the buildings are to be erected, etc. Not infrequently the various buildings composing a large plant can be constructed of different materials, without militating against the efficiency of the plant as a whole, either from the standpoint of fire hazard or industrial requirements, and by so doing the expenditure necessary for this part of the plant may be minimized.

Many illustrations could be cited to show the influence that the manufacturing work may have upon building types, and on this account it is necessary that the industrial engineer should be quite as conversant with the characteristics of the various types of construction that are in use, as he must be with the requirements arising through the conduct of the business that is to be housed. The absence of vibration in a properly designed, reinforced-concrete building, where high-speed machinery has been installed, makes the system preferable for such purposes, etc.

It must always be borne in mind that the nature of the contents of an industrial plant, and the fire hazard presented by outside conditions, are the governing factors in connection with the selection of the type of building construction best suited to comply with the requirements of fire protection. In some cases the adoption of reinforced concrete eliminates the need of a sprinkler system, although usually this is not so. A properly designed building of mill construction, if protected with sprinklers, fire-fighting apparatus and cut-off walls, is in many cases as reliable as industrial conditions demand.

The question of appearance of buildings has been previously touched upon, and where an attractive plant is desired the character of the buildings that should be located upon the front of the property must be selected with this requirement in mind. In most cases there

is a logical front to a building site dependent upon the layout of streets, railroad facilities, railroad stations, and street-car lines.

P-m. Reconsider all work done so far and prepare a revised layout incorporating, as far as possible, the best features of the various preliminary studies. Make outline drawings of buildings.

The time has now arrived when the final block plan or property layout can be prepared, and as a number of alternate schemes will probably have been suggested, it is necessary to make every effort to incorporate the good features of each of these in the final plan. By this time there is not likely to be much doubt as to which property, among those under consideration, is most desirable, all things considered, so that the block plan that I now refer to must be accurate and final in every particular.

Previous consideration will have been given to the question of railroad facilities, but now the approval of the plans by the trunk-line railroad upon which the property is located must be secured, and all other questions relating to the site that may have been settled in only a tentative manner must be defined beyond any misunderstanding.

Following the completion of the final block plan, accurate outline drawings must be made, illustrating all the principal characteristics and giving the essential dimensions of the various buildings, or enclosures, required. These drawings are necessary both in connection with the preparation of the estimate of cost and for the purpose of making clear to the owner the exact character of plan that is recommended. If the plant is of considerable size, it is also desirable to prepare a large perspective drawing showing the layout as a whole.

P-n. Prepare a classified estimate of cost based upon unit prices.

An estimate of cost must now be made, covering the expenditure necessary in order to carry out the entire work contemplated by the drawings and notes recorded during the performance of the work that has gone before. This estimate should be classified so that the costs of the principal items entering into the layout can be considered separately. As a matter of fact, such an estimate should be based upon the unit-cost figures, for the plans and specifications should not as yet have been carried to the point where the actual quantities of materials can be ascertained and the amount of labor estimated. An important part of the data carried in the records of engineering organizations which specialize upon industrial work has to do with such unit costs as I refer to, and if proper discretion is exercised in its use the total figures arrived at are usually found to check closely with the actual expenditures incurred.

The cost of multiple-story reinforced concrete buildings can be estimated with reasonable accuracy upon a basis of so much per cubic foot, depending upon the floor, loading, general character of the building, etc. The cost of heating by direct radiation can be estimated upon the basis of so much per square foot of radiation, depending upon the temperature desired, the locality of the plant, the character of the building, etc. Many other important items of expense can be readily worked up in the same manner, although it is, of course, necessary to secure definite lump-sum figures upon all special equipment or unusual provisions entering into the plant.

P-o. Determine whether estimated expenditures would result in a "fixed charge" consistent with the probable profits of the business; i. e., can the business carry the necessary investment.

The estimate should now be presented to the owner, who, with the engineer in consultation, should decide whether the expenditures required will result in interest and depreciation charges that are greater than the business can properly stand. Very frequently decision in this regard must rest upon the broad judgment of the owner, rather than upon definite figures arrived at through preparation of detailed estimates of operating expenses. If it is decided that the expenditure is excessive, after taking into account all probable advantages that it would provide, the plan must be consistently modified with a view to curtailing the first cost. It is impossible to lay down any definite rule for accomplishing this, for every commission presents somewhat different conditions; but the engineer should by this time have gained an insight into the entire problem that will enable him to decide with reasonable promptness where the necessary economies can be effected.

P-p. Determine whether owner is prepared to make the total justifiable expenditure.

Not infrequently the owner may not be prepared to make the requisite expenditure, even though conditions may indicate that they are entirely warranted; and if this is the case, it is very necessary that the engineer should take a firm stand in regard to the policy that should be followed, for only too often the value that should accrue from the preliminary investigations is in a large measure lost through too hasty a readjustment of the plan. The engineer, of course, must co-operate with his principal to the fullest extent, recognizing the need of keeping well within the funds that can be surely counted upon as available for the work. He must remember that successful concerns are constantly extending and developing, and that the pur-

pose of the preliminary study is primarily to arrive at a plan of development that can be followed out either to the full extent warranted by business conditions, or to the limit of the available resources of those who have in hand the business in quesiton.

P-q. If financial limitations (P-o or P-p or both) require it, revise the layouts and prepare data and plans suitable as a basis for the preparation of architectural and engineering plans.

If the owner decides that he cannot build to the extent that the approved estimate requires, it is necessary that the engineer should be especially firm in his stand for a proper disbursement of whatever money is spent, for particularly at this time he must guard against assenting, through pressure that may be brought to bear by the owner, to a plan of procedure that would militate seriously against the ultimate efficiency of the new plant.

The result of the foregoing preliminary work should be an approved layout of buildings upon the property, the exact definition of such matters as service and manufacturing equipment, railroad facilities, building types and sizes, etc., and it remains as a final step only to tabulate all the data and to prepare such further sketches as may be required as a basis for the preparation of the detail plans and specifications for the architectural and engineering features. This brings us to the second broad heading of the classification of work incident to the planning and building of industrial plants.

In concluding what I have had to say regarding the preliminary work, I wish to repeat that as a rule the principal questions at issue demand for their solution only a moderate amount of originality upon the part of the engineer in direct charge of the work, whereas his intimacy with what has already been done, coupled with his ability to co-operate with others and to arrive at sound conclusions after the facts have been ascertained, in a large measure govern his success. The faculty of observation, together with a mind that will unconsciously analyze reasons for conditions with which it comes in contact, are a necessary part of his equipment. The effort should, of course, be made to solve each operation in a more efficient manner than had previously been done, but little progress will be made except by those who profit to the fullest extent by past performance in the same field of activity.

GRATE AREAS FOR WATER-TUBE BOILERS.

By T. F. J. Maguire.

IN order to obtain good results, the furnace for any given boiler must be capable of burning the fuel in an efficient manner, and in addition, it must have sufficient capacity to develop the required output of the boiler. With solid fuels, the most important feature of the furnace is the extent of grate area to be employed for any given installation.

A boiler and its furnace are apt to be considered as a single piece of apparatus, when as a matter of fact they are entirely distinct and have different functions to perform. If a boiler is well designed, it will give satisfaction within the limits of its capacity, under the most diverse conditions of operation. The function of the boiler is to transfer the heat contained in the hot gases passing over its heating surface to the water contained by it, generating steam and thus creating energy in a usable form. The heating surface must be consistent with the capacity for which the boiler is built, and so arranged with respect to the path of the hot gases passing through the boiler setting as to absorb as much heat as possible from the gases before they escape from the setting. In addition, the boiler must provide for a free liberation of the steam and an efficient circulation of the water. Any standard boiler satisfying the above requirements is practically satisfactory for any plant, without modification in its features of design.

In the case of the furnace, however, the case is entirely different; and it might be stated that for the attainment of best results, each particular installation requires a furnace specially designed to satisfy the local conditions. The function of the furnace is to convert the potential heat of the fuel into heat contained in the gases of combustion given off by the furnace, and to generate this heat at the highest practicable temperature. Not only must the furnace be capable of making this heat conversion efficiently, but it must have sufficient capacity to drive the boiler at the required maximum output. The proper furnace to employ is determined by the fuel that is to be used, and by the output at which the boiler

is to work. A perfect furnace would transform all the heat in the fuel into heat contained in the gases given off by it, delivering these gases at the highest possible temperature. In the perfect furnace the rate of feed of the fuel would vary with the boiler output, the air supply would be just sufficient to burn the combustible matter of the fuel completely, there would be no fuel lost in the ash, no loss due to radiation from walls of furnace, and the furnace would automatically dispose of the ash without interfering with the process of combustion. In all practical furnaces, however, there are bound to be losses due to the inability of the furnace to respond quickly to a load variation on the boiler, to the impossibility of operating at all times without deficient or excess air, to the unavoidable presence (with solid fuels) of a certain amount of carbon in the ash, to radiation, and to the chilling effect when fires are being cleaned.

The location of the furnace with respect to the heating surface of the boiler depends upon the kind of fuel employed. The arrangement should be such as to provide a path of sufficient length for the gases before they reach the nearest heating surface, so that they may have ample time to burn completely before impinging on the heating surface. As the heating surface rapidly absorbs heat from the gases, with a consequent lowering of temperature, combustion practically ceases after impingement. For coals such as the anthracite, semi-bituminous, and Eastern bituminous, in which the combustible matter consists principally of uncombined carbon, the grate may be placed relatively near to the boiler heating surface; but for Western bituminous and lignitic coals, in which the combustible matter is largely composed of volatile hydrocarbons, it is essential, for good economy, to provide a considerable path of travel for the gases from the grate to the nearest heating surface.

The following matter applies particularly to flat, hand-fired grates, with coal as the fuel. Many of the statements, however, apply equally well to other solid fuels, and to automatic stokers.

The grate area required for any given boiler depends upon the grade of fuel to be used, and upon the output at which the boiler is to be operated. It is necessary to distinguish between the normal rating of the boiler (the builder's rating) and the maximum output which the boiler will be called upon to deliver. A certain size of grate might be capable of working a boiler to its rated capacity, but might be inadequate to drive the boiler for any

length of time at an appreciable overload. Practically all boilers, with their furnaces, are guaranteed by the makers to operate, for a certain time, at a certain load in excess of the rated capacity, this overload being usually between 25 and 50 per cent in excess of the rated capacity of the equipment. The length of time during which the equipment will be called upon to develop the guaranteed overload has also an important bearing upon the grate area. With the grade of fuel known, and the desired overload and its duration determined, the size of the grate area depends upon the number of pounds of fuel that can be burned per square foot of grate per hour, or upon the rate of combustion of the fuel. The rate at which a given fuel may be burned depends, in turn, upon the available furnace draft. It must not be supposed, however, that the number of pounds of fuel burned per square foot of grate per hour can be indefinitely increased by a proper increase in the furnace draft. With an excessive furnace draft, the furnace efficiency will be comparatively low, on account of excess air, the formation of holes in the fuel bed, and the rapid accumulation of ash on the grate. An excessive furnace draft, and consequent excessive rate of combustion, are not conducive to economical operation, especially for coals that clinker or that are high in ash.

The size of the grate and the intensity of the furnace draft depend upon the grade of coal to be used, and upon the rated and maximum output of the equipment and the duration of the maximum output. If the load on the plant is such as to require the boiler and its furnace to operate for extended periods at the maximum guaranteed capacity, then the grate area should be liberal enough to maintain the boiler pressure without the use of an excessive furnace draft, as the employment of the latter gives poor operating economy. It is a difficult matter for any furnace to hold up the steam pressure if the grate area is insufficient, owing to the rapid accumulation of ash on the grate and the necessity of frequent cleaning of the fire. Too large a grate area is also detrimental, because of the comparatively thin fire that must be carried and the resulting tendency to the formation of holes in the bed of fuel. It quite often happens that boilers and furnaces are installed of a rated capacity considerably greater than the actual load they are called upon to carry, and on account of excessive grate area the operating economy is poor. The efficiency of the boiler does not vary widely with the load, and even at an overload of 100 per cent, the boiler efficiency will hold up remarkably well.

The furnace efficiency, however, is very sensitive to the load, especially at extreme overloads and underloads, and therefore the rated capacity of the furnace especially (and hence the grate area) should receive the most careful consideration, with relation to the kind of load that it will be called upon to carry. In general, it may be stated that for any apparatus the best efficiency is obtained when it is operated at its rated capacity, and this is particularly true of furnaces.

It is a simple matter to work out an expression for the grate area, and also for the relation existing between the heating surface of the boiler and the grate area.

Let HP=rated horse power of boiler—the maker's rating.
let f=the overload required—that is, if an overload of 25 per cent is required, then f=1.25.
let E=the evaporation from and at 212 degrees F. per pound of dry coal, or the number of pounds of water, corrected to 212 degrees F., that one pound of dry coal will evaporate at the given overload.
let R=rate of combustion of the dry coal burned per hour per square foot of grate area.

As a boiler horse-power is defined as the evaporation of 34.5 pounds of water from and at 212 degrees F., the water from and at 212 degrees F. evaporated by the boiler when developing an overload f is evidently equal to 34.5 f HP and the pounds of dry coal burned per hour is equal to 34.5 f HP divided by E. The required grate area A in square feet is therefore given by the expression

$$A=\frac{34.5\ f\ HP.}{E\ R.}$$

It is customary, at present, to rate water-tube boilers on the basis of 10 square feet of heating surface per boiler horse power. Thus a 400 horse-power boiler would contain 4,000 square feet of effective heating surface. For a rated horse power "HP" the effective heating surface of the boiler is 10 HP and ratio of heating surface to grate area is

$$\frac{E\ R}{3.45\ f}$$

With the rated capacity of the boiler, the required overload, the evaporation from and at 212 degrees F. per pound of dry coal and the rate of combustion known, it is an easy matter to determine the proper grate area, and the relation of the latter to the heating surface of the boiler. The rated capacity of the equipment, and the required overload, are invariably determined by the prospective purchaser, while the rate of combustion of the coal, together with its evaporating ability, are usually determined by the makers of the apparatus. It is evident that for best results a knowledge of the kind of coal that is to be used is very essential. The proper evaporating ability and rate of combustion to assume for any given coal are based upon previous tests made on the coal under consideration, or upon similar coals. Coals mined in certain sections of the United States are similar enough in composition, calorific value, and evaporating ability to be classed under a single head so far as the grate areas are concerned. Below are given the grate areas for certain of these classes of coals, it being assumed, in every case, that the boilers are to develop an overload 50 per cent in excess of the rated capacity.

Eastern bituminous and semi-bituminous coals of 13,000 B.t.u. heat value per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 19 per cent of the rated boiler horse-power and the ratio of the heating surface of the boiler to the grate area is 52 to 1. At rated capacity, the evaporation may be taken at 9.4 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area the rate of combustion would be equal to about 19 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent could be easily maintained with a grate area equal to 1/52 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Eastern bituminous and semi-bituminous coals of 13,500 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9.5 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulæ,

the grate is equal to 18 per cent of the rated boiler horse-power and the ration of the heating surface of the boiler to the grate area is 55 to 1. At rated capacity, the evaporation may be taken at 9.8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 19.4 pounds of dry coal per square foot of grate per hour. For these coals, with the proper furnace draft, an overload of 50 per cent could easily be maintained with a grate area equal to 1/55 of the heating surface of the boiler, with good economy at both rated capacity of the boiler and the given overload.

Western bituminous coals of 12,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.1 pounds of water per pound of dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 21 per cent of the rated capacity of the boiler, and the ratio of the heating surface of the boiler to the grate area is 48 to 1. At rated capacity, the evaporation may be taken at 7.6 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to 1/48 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Western bituminous coals of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.2 pounds of water per pound of dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 24 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 42 to 1. At rated capacity, the evaporation may be taken at 6.7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to 1/42 of the heating sur-

face of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 3, of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.6 pounds of water per pound of dry coal, and the rate of combustion at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 36 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 28 to 1. At rated capacity, the evaporation may be taken at 7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to 1/28 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 2 of 12,000 B.t.u. value per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.6 pounds of water per pound of dry coal and the rate of evaporation at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 31 per cent of the rated capacity of the boiler and the ratio of the heating surface to the grate area is 32 to 1. At rated capacity, the evaporation may be taken at 8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to 1/32 of the heating surface of the boiler, with good economy at both rated capacity and at the given overload.

The above list might be increased indefinitely to cover all solid fuels, and the examples given are simply to illustrate the method of obtaining the proper grate area for any given set of conditions,

INVESTIGATING MARL DEPOSITS FOR PORTLAND-CEMENT MAKING.

By Fred. Fisher.

THERE is a very general misconception concerning marl as a source of carbonate of lime for Portland-cement making. While nine out of ten technical experts in the industry have an unreasonable prejudice against any marl proposition, the general public have an equally erroneous idea, ascribing great value to every deposit of the material. These false ideas are due to a lack of appreciation of the factors that differentiate between valuable and absolutely useless matter. Most marl beds, I concede, come under the latter designation, but there are many good deposits which are possible sources of raw material for the growing cement industry.

Neglecting the obvious items of locality and available quantity, the two vital factors are the absence of quartz sand and the percentage of water in the marl. Too many marl plants have proved failures—many, indeed, from having been poorly designed originally, cheaply constructed, and badly financed; but primarily most of the failures have been due to an insufficient supply of marl of a grade fitting it to produce cement at a profit.

Any marl, if free from sand, will make good cement, if properly handled; but to do so at a profit is a matter of much greater moment. Marl, as here referred to, is a mud-like deposit of carbonate of lime, precipitated from a saturated solution of the bicarbonate, either by changes in temperature or through the action of vegetable organisms, and to a lesser extent, the shells of fresh water mollusks have contributed to its formation.

From the cement-maker's point of view, the marl of importance is the heavy and rather granular solid deposit, due principally to the first mentioned cause and in less degree of the others, in which vegetable life has ceased, leaving little peaty residue. Such marl is very heavy, carrying but half (or less) of its weight of water, as it is dredged from the bed.

The majority of marl deposits, however, do not fulfil these conditions, but are more or less impregnated with living vegetable tissue. I have known marl in apparently good condition—nearly white and

solid—that carried more than 85 to 90 per cent of water, in its natural condition. The following table shows the significance of this phase of the marl subject.

QUANTITIES PER BARREL FINISHED CEMENT.

Percentage of water.	Cubic yards of marl.	Pounds of water carried by marl and clay.	Pounds of coal consumed	Daily output.
40	0.29	400	90	250
50	0.39	560	120	160
60	0.54	800	170	90
70	0.75	1,200	250	50
80	1.40	2,000	410	35

The first column shows the percentage of water in the marl; the second, the quantity of marl needed in cubic yards; the third, the weight of water that would have to be evaporated from the material; the fourth shows the number of pounds of coal needed to remove the water and to clinker the cement; the fifth column gives an estimate of the daily production of each kiln using such material. The figures of the last two columns are only relative, as the fuel consumption and the output of the kiln are dependent on the size and design of the unit.

With poor material the relative output falls off faster than the fuel consumption increases, because of the fact that the possible consumption of coal in the kiln decreases as the material gets poorer, the amount of coal that can be burnt being limited by the necessity of keeping the maximum temperature at the point of combustion, but below the critical point at which the clinker would be over-burnt.

Further comment is hardly necessary, as the above figures are self explanatory from a profit-making point of view. My experience as superintendent of a marl cement mill indicates that the deadline between profit and loss lies at about 50 per cent of water in the marl. With marl heavier than this the cost of production steadily gets lower, and at about 40 per cent I consider marl a cheaper material to use than rock, because of the greater ease in handling in the various stages of the operations, from the excavation of the material to the burning. A cement material carrying 40 per cent or less of water is practically as cheap to burn as dry material, and will give as good a production, in a properly designed mill. This is due to the fact that there is sufficient heat left in the waste gases to evaporate the water, without affecting the output of the kiln, or the amount of coal needed.

The amount of sand in the marl is of equal importance. Very many otherwise excellent deposits—heavy, solid material—are abso-

lutely ruined by their content of sand, either uniformly distributed to the extent of 1 to 2 per cent, or in distinct layers, but so disposed that it is imposible to excavate the marl uncontaminated with more or less sand. This condition is fatal, as it is not practical either to remove the sand or, when thus mixed with the marl, to grind it to a sufficient degree of fineness to allow it to be considered as one of the cement materials. Nine-tenths of all the poor cement made by the marl cement plants has been due to this factor, and it is this which, in some districts, has caused a prejudice against the product.

In surveying a marl deposit the test holes from which samples are taken to determine the quality serve also to give a basis for determining how many yards of material can be depended upon. The amount of cement this would represent would depend on the quality of the marl, as indicated by the above table. The amount lost in handling would depend on the method employed in excavating, and would vary from practically nothing to half of the original deposit. Excavating with a dredge floating on a lake above a deposit is very uncertain and generally exceedingly wasteful, as much of the marl is washed away, and it is impossible to clean up the deposit closely. On a 6- to 10-foot deposit this loss could easily amount to 50 per cent. When the lake or marsh can be drained and the material dug "dry," the loss can be kept very low. Where it is not possible to drain by ditching, but the conditions are favorable for the water to run off, centrifugal pumps can be used to advantage to remove the water. Considerable expense for this detail would be amply justified by the advantages gained.

While the above factors determining the value of marl deposits seem very simple, they have seldom been appreciated as they should be by those authorized to investigate marl properties, on the basis of whose reports heavy investments have been made. Within a few months I have been called upon to pass judgment on two reports from sources that ordinarily would not be subject to any possible question. In neither case was there any record kept, or attempt made to determine this all-important item of the water content of the marl. In each case the report as to quality was based upon quantitative chemical analysis of the *dried* material. In one case no attempt was made to distinguish between the silica present as crystalline sand, and that combined in clay or other harmless minerals. Such reports as these (and this is the character of many reports I am familiar with, on which most of the marl enterprises have been based) are primarily responsible for the ill repute under which the marl industry suffers.

EDITORIAL COMMENT

Peary and Cook.

THE controversy over the reaching of the North Pole is not without historic precedent. Records of research, discovery and invention in all fields show many quite similar cases of coincident announcement by independent seekers, and of bitterness of factional contention afterwards. It is possibly our extreme nearness to the event and the men that makes this particular affair seem so unpleasant.

A point which becomes painfully apparent, however, as the first report is supplemented by later despatches, is Peary's fixed jealousy of purpose to be alone in reaching the pole. No zeal for scientific achievement—nothing but desire for personal aggrandizement—could demand that but one responsible observer should reach latitude 90 degrees North. The man who could turn back such a colleague as Bartlett from the 88th parallel, would hardly tolerate the claims to success of a rival explorer. This consideration must weigh heavily in estimating Peary's attack upon Cook. It is one of the first axioms in the examination of evidence that a witness's testimony loses weight in direct proportion to his animus.

An opportunity to crown the achievement with honor and prestige, to dignify the comparatively slight scientific value of the expedition by giving it an emotional value which would have worked out to great practical good, was offered to Peary and blindly, but forever, thrown away when he sent Bartlett back.

To Bartlett himself, fit and able as ever for the final dash, but grimly turning back in obedience to discipline after he had broken the track and smoothed the road to the very last stretch south of the Pole, our tribute of respect and honor.

And to the mother of Prof. Marvin, in her inexpressible grief, a sorrowing sympathy too deep for words.

An Effective Fulton Exhibit.

IN the Hudson-Fulton pageant, with its 7 miles of warships and 150 miles of illumination, the things of the present almost overwhelm the central figures representing the past, and the very magnitude of the ceremony makes it hard to realize the event of 1807 as it impressed itself upon the civilization of its day.

The exhibit arranged by the American Society of Mechanical Engineers, through the courtesy of the Smithsonian Institution, makes it much easier to restore to mind the real proportion of Fulton's work in the simpler atmosphere of his time. This exhibit, open to the public in the Society's rooms in the Engineering Societies' Building, 29 West Thirty-ninth street, includes models of the Clermont, the Phoenix, built by John Stevens, and one of John Fitch's earlier types of steamboat. There are also original drawings by Fulton, an oil portrait of Fulton, painted by himself (this being the one which was reproduced in THE ENGINEERING MAGAZINE, March, 1904), Fulton's dining table, and also oil portraits and a bronze bust of John Ericsson, with models of the Monitor, which are the property of the Society, and Ericsson's personal exhibit at the Centennial Exposition.

The model of the Clermont represents the boat as she was on her first trip, before the hull was shortened and other changes made to fit her for regular passenger service. The model of the Phoenix shows that boat at the time of making the first sea voyage ever undertaken by a steam vessel. The trip was made in 1809, leaving New York June 7th and arriving at Philadelphia June 17th.

Fitch's boat, which was equipped with a steam engine operating six oars, was built in Philadelphia in 1786 and successfully used on the Delaware River.

The exhibition will be open to the public every week day from 9 A. M. to 5 P. M., and it has been prepared with the purpose of making it of general and not merely of technical interest.

Harriman.

THE total or net result of an influence like Harriman's it is perhaps impossible to estimate until distance in time corrects the disproportions of too close a view and gives a complete perspective of the man's entire work. In the financial world he was affiliated with some of the worst methods that have characterized the operations of American "high finance," and to many he will continue to appear as he stood revealed by the light of the Alton and Equitable disclosures. In practical railroad management, however, as distinguished from speculative, he was one of the earliest and greatest influences for far-sighted wisdom in the physical improvement of track and equipment, and in advanced policies for improving the efficiency and economy of maintenance and operation. His work here, both in itself and in its example and effect upon other managing and operating officials, will have a permanent and marked influence for good upon the economic welfare of the United States. The Harriman of Wall Street we may hope will pass away, or at least will remain only a regrettable memory in an era of higher moral tone in the United States. The Harriman of the Union Pacific we may hope to see emulated and bettered in the practical railway men of the decades to come.

Railway Betterment Opportunity.

BETTERMENT of efficiency in railway operation, indeed, offers an economic opportunity of probably larger national importance, financially measured, than any other equally easy of realization.

Harrington Emerson, a leading authority upon industrial efficiency, calculates that in maintenance of motive power alone, American railways incur a wholly preventable waste of $80,000,000 per annum—about as much as the total annual gold production of the United States. The preventable wastes in maintenance of way are perhaps less, and in the transportation departments probably much greater than this. This costly inefficiency is due chiefly to general lack of any standards by which to test performance. Railway leadership in the past has looked to more sensational and more spectacular movements than the simple reduction of costs and upbuilding of efficiency. In the new railroad era just opening, the operating official who can realize the enormous savings which a few roads here and there have shown to be possible, will come into his own and be recognized as the railroad king of a new dynasty.

A Revision of Figures.

A REVISION of certain figures in Mr. Darlington's article, "The Substitution of Electric Power for Steam on American Railways," was sent us after the September sheets were off the press, and hence was too late for note last month, although it is important enough to be recorded.

The table at the head of page 908 should have been headed "Average Cost of Electric Railways in the Middle Western States" *"under conditions favorable to cheap construction."* The costs given in the table, while taken from figures established by actual experience, are lower than the average cost of all interurban roads in the middle west of the United States.

Further, the statement beginning at the foot of page 907 and continuing in the text below the table on page 908, "the return on cost must be small where the * * * net earnings are less than $1,800 to $2,400 per mile" should read: "less than $1,200 to $1,600 per mile."

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE PROBLEM OF THE YOUNG TECHNICAL GRADUATE.

THE CAUSES OF HIS UNPOPULARITY WITH MANUFACTURERS AND A SUGGESTED REMEDY.

Frederick W. Taylor—Society for the Promotion of Engineering Education.

AT the recent meeting of the Society for the Promotion of Engineering Education, Mr. Fred. W. Taylor made the startling statement that the overwhelming majority of employers in the United States wish to have nothing to do with the young technical graduate if his employment can by any means be avoided. We have already commented editorially, in our August number, on Mr. Taylor's criticism of the faults of technical training in the schools, and the remedy which he proposes to apply. His argument is given a more extended presentation below, from an abstract of his address published in *The Electric Journal* for September.

As to the value of the young engineers, there should be no question in the mind of any impartial investigator as to the enormous value of an engineering education for success in actual, practical life, in commercial life, in manufacturing life, and in engineering life. But there is not the shadow of a doubt that the overwhelming majority of employers in this country want to have nothing to do with them if they can help themselves. Those who have had the longest and widest experience with college graduates want them the most, but, in general, they want them only after they have been out of college for one or two years. They want some one else to take them first. It is true that there is one important exception to the general rule, the large electrical companies, who are employing young college men on a large scale; but to a large extent these companies are exploiting the young engineers, and the opportunities they offer are in no way comparable with those which would be open to the same men in smaller and more diversified industries.

"Now this is one side of the question. The other side comes to me from my personal observation. I think it is also true that nine out of ten of these young men are dissatisfied for at least one or two years. They find their employers unappreciative and exacting. They are not given any kind of opportunities commensurate with their education and what they are able to do. They are asked to do work that mere boys could do. Almost invariably, they want to leave their first employer, and it is only after going to their second or third that they become aware of the fact that the boys that they make light of are the ones who can do things and are the ones favored by the employers, and that the whole or nearly all of the employers of the country are not really unappreciative. Some ten years ago I made up my mind never to employ a college man who had not been out two years at least, if I could help myself. Then he will have learned something about life and what the world is."

Is it necessary that the young graduate should leave college with an education which is of no value in the eyes of the

average employer, and that he should be unhappy and discontented for a period of one or two years after graduation? There are two particular faults responsible for this condition of affairs, both of them remediable. The first of these is because of the fact that during the four years these young men are at college, they are under loose discipline, and are allowed a greater freedom than they have ever had before, or will ever have again. They absent themselves from lectures, from duty that belongs in the college course, and no one asks what they have done or where they have gone. They work as they please and as much as they please, the only restriction being that they have to pass certain examinations. Their habits are left almost entirely to themselves. But when they begin commercial life those habits are regulated and rigidly prescribed by some one else, and the process of readjustment is a most painful one. The second fault is due to the radical difference in the treatment which the young men receive in college from what they receive afterwards. For twenty-two years or longer they are allowed to go without even a single look at conditions which they are to face throughout their lives. The work of the student is that of absorbing ideas and knowledge for his own use. For twenty-two years he is served by some one else, but the moment he gets out of college he begins serving others, and he finds the greatest difficulty in suddenly changing from the attitude of the receptive student to that of the active servant. The entire emphasis of the college life is on intellectual training, but for success in life intellectual training is not so important as either character or good sense.

"What is the remedy for these two faults? I do not believe there is any panacea for all faults, but I do believe that there is a great palliative possible. I believe that every young student in our colleges, from the student who intends to be a minister, on the one hand, to the mechanical engineer, on the other hand, should leave college at the end of the freshman year and spend at least one year in actual hard work in a shop of some kind. I say shop, because he will be certain to be under careful and constant supervision when working in a shop as a workman, alongside workmen.

"I would not send them there with the idea of getting intellectual training. If they do, it is a mere incident. I would send them there mainly for the purpose of giving them a real look at life's work and give it to them early enough to affect the least three or four years of their college life. When they start work in a shop, under good rigid discipline, they then begin to get the character training, which is almost entirely lacking at college. They then begin to learn the great lesson of life, that almost nine-tenths of the work that every man has to do is monotonous, tiresome and uninteresting. Then they start to develop the character which enables them to do unpleasant, disagreeable things. This is the greatest training, to my mind, which they get in the shop. They learn that life is made up mainly of serving other people, not that the world is there to teach them something new. I think they almost invariably start into the shop with the common idea, 'Now I am here to learn something, to get something in this shop that is going to be a fine engineering education for me.' They fail at once for there is no great intellectual training in the shop. Many of them cannot stand the monotony and fail to get the real character training that comes from that work."

Another thing which young students learn in the shop, and which has more to do with making them earnest and determined than anything else, is that the uneducated workmen with whom they come in contact are mentally as well equipped as they are. When a young man gets it clearly into his head that it is energy, determination and character which make for success in manufacturing and engineering, and that in superior education lies his only security against being outstripped by men of the common ranks, he goes back to college with a proper appreciation of the sort of education he needs and a determination to get it.

"At college a very large amount of time is given up to the study of materials. Practically the student's whole

chemical course is the study of materials. A very considerable part of his course in physics has to do with materials. The greater part of his work in a mechanical laboratory is a study of materials. But men, the great raw material with which more than one-half of the successful graduates of our technical schools have to deal, receive not one single hour of study at our colleges and universities. At twenty-two years of age young engineers land outside of college without the slightest knowledge of the great raw material with which more than one-half of them will have to work throughout their lives." It is next to impossible to study workmen from the top. The only way in which a man can become familiar with the line of thought of his workmen, with the process of reasoning by which they approach the great problems that are in their minds, is by becoming intimate with them, by working side by side with them, so that they forget that he is not one of their kind. Just now one of the greatest problems of industrial management is that of soldiery, and no man can properly and thoroughly appreciate this great problem until he has worked among men when they soldier, knows their arguments for and against the practice, and has some idea of how to remedy this great defect of modern industry.

"Now there one more thing. More and more, management is becoming a question of co-operation on a large scale. The whole training of the young man while he is at the university is an individual training. He has not the slightest training in co-operation, except possibly what he gets from his baseball or football team in the university; and yet every year the problem of co-operation becomes a greater one. These young men at twenty-two go out without having seen any co-operation, thoroughly unfitted for it in many respects; thoroughly unfitted to do what they are told promptly and without asking questions and making suggestions. They will not become one of a train of gear wheels, and it is absolutely necessary for every man in an organization to become one of a train of gear wheels. The training he usually receives in no way fits him for that, but a year in the shop will give him at least a good look at it. He has to work as one of a train of gears during that year. I do not think there is any equivalent for this work. Certainly the university shop is in no wise an equivalent. There they are in competition, not with men who are engaged in working for a living, but with other students. They are not rubbing against other men and getting their viewpoints, learning something as to how work ought to be done. They may get a little good out of it, but as far as the great work they ought to have, the character training and the study of men, they get nothing. The thing that comes close to it in college is the three or four months of vacation work. Even during this time, however, they fail to get it because all they do is to go in there with the idea of learning something. It is a novelty to them and they fail to get right down to the real monotonous grind which trains character. Then again, in three months of summer vacation work, they cannot get close enough to the workmen to know their viewpoint.

"About ten or twelve years ago I made up my mind not to take another young college graduate unless he has had two years' work outside, but, in going through the list, I found that there was a certain set of young men who were satisfactory right from the start, men who had by necessity been forced to leave school and go to work. So I found that I had to modify my conclusion, by saying that I would not take a man unless he had worked outside for at least two years, or unless he had worked as a workman before he graduated. I have no other reasons why these young college men were not competent but the facts are there.

"The joint committee appointed by seven of the English engineering societies, with, I think, three of the professors from the universities, unanimously voted that it was desirable to have two years' apprenticeship before students graduated as engineers. I think that is a very remarkable recommendation. It

goes very far towards bolstering up the theory which I have formed, that the accredited representatives of seven great engineering societies of England should recommend unanimously two years of apprenticeship before being allowed to graduate as mechanical engineers, or as any other kind of an engineer. Now, in so far as the post-graduate courses in our engineering colleges interfere with the good that the coming in touch with actual work will have, just to that extent those post-graduate courses in our colleges are bad and very much to be deplored. I do not think that the average young man needs any post-graduate course. He needs other things. He needs closer touch with actual life, and this tendency in our universities to lengthen their courses out to five or six years is a most unfortunate change. Certainly, to the average man it is a step in entirely the wrong direction.

"Is it possible or practicable to get this year's work for the young graduate? I feel absolutely sure it is, provided those young men are sent out to work in working conditions. If they are sent out to get an education, no. But if they are sent out and made to do a day's work, they are the finest kind of raw material. Take the average young man. He has some bad ideas, but all you have to do is to mould that young man to your needs, give him character and common sense, and when the shops begin to take these young men from our universities and colleges, particularly if it becomes a regular thing that every year from such and such a place we can get eight or ten men, the supply will not equal the demand."

THE TESTING OF ROAD MATERIALS.

NOTES ON THE SELECTION OF GRAVELS AND ROCKS, AND SPECIFICATIONS FOR BITUMINOUS MATERIALS.

Austin B. Fletcher—The Engineering Record.

ONE of the latest additions to the valuable data which have been accumulated through the investigation of the problems of highway construction and maintenance by the Massachusetts Highway Commission, is a set of specifications for the bituminous materials used as binders for road surfaces. In a recent paper before the First Congress of Road Builders, Mr. Austin B. Fletcher says that it is still too early to expect standardization of the essential characteristics of these materials, and that much further investigation is necessary before final specifications can be drawn; he presents the Massachusetts specifications only as probably the best that can be drawn at present, as they represent the best materials so far offered for bituminous road binders. We give them in full below, with a brief abstract of the rest of Mr. Fletcher's paper, from *The Engineering Record* of July 31.

With the single exception of earth or loam, sand and clay in combination form probably the lowest type of material available for road purposes. Loam should never be used if anything better is obtainable at a reasonable cost. With careful and skilled attention loam roads can be kept in excellent condition during summer, but in the spring the condition of such roads is intolerable. Sand is at its best in the winter and spring, but does not have sufficient stability to sustain traffic. Clay is open in a greater degree to the same objection as loam. By combining sand with clay in proper proportions a fairly serviceable road for light traffic may be obtained in localities where the climate is favorable, but where gravel is obtainable, even of inferior quality, such a road should not be considered seriously.

Gravel is a very widely distributed material, but all gravels are not suitable for the purposes of road construction. Unless the pebbles are combined with the sand or with the clay in proper proportions, the gravel without treatment may be of little value. Between the sandy

and clayey gravels, the choice should be usually in favor of the former, unless the clay is in relatively small proportion. Too much clay makes a muddy road and one easily rutted by traffic. Too much sand, with large pebbles, makes a mass with little or no stability, which it is impossible to compact. For the best results with ordinary gravels, all stones that will not pass through a 2½-inch screen should be thrown out; at least 50 per cent by weight should not pass through a 1¼-inch screen; at least 80 per cent by weight should not pass through a ½-inch screen; the remainder should consist of small fragments of pebbles and sand from less than ½ inch in diameter to an impalpable powder. A gravel so graded has great stability in the road when properly rolled. If the pebbles are of crystalline or eruptive rocks, the road will make but little mud under traffic and should not rut to any considerable extent even when the frost is coming out of the ground.

In general, the chief desiderata in rocks for road building are hardness and toughness. Toughness is the more important. It is possible that in modern roads, those in which some form of bitumen is used as a binder or matrix or as a wearing coat, stones of somewhat inferior quality may be used with safety. To make a choice between stones for macadam purposes no scientific instruments of precision are required. The stone hammer and scratching tests are all that are necessary. Rocks having a fine texture are, in general, more likely to be tough than those having a coarse, crystalline structure. Where there is not an excess of motor-vehicle traffic, a smooth surfaced road will be more often secured if ledge rock is used rather than field boulders. While the field stones may be harder and tougher than the ledge rock in the locality, the lack of uniformity between them is likely to give rise to unequal wear in the road surface in which they are placed. Under very light traffic or where motor vehicles predominate, a relatively soft rock will often prove to be more economical than a relatively hard one; for these conditions also, a good gravel road, if suitable materials are obtainable, will usually prove to be more economical than a road of the macadam type. For macadam roads it has come to be generally accepted that trap rock is the best, and that the felsites, hornblendic granites, harder limestones, schists, and quartzites follow in the order named.

No macadam road which will receive much motor-vehicle traffic should be planned without taking into consideration the effect of the tangential stress exerted by the driving wheels upon the road surface, and the provision of a binder for the broken stone. Thus far bituminous materials seem to be the only ones suitable for road surfacing, and the coal tars, asphaltic oils and asphalts have been used for this purpose. Simple tests for these materials cannot be recommended; only elaborate chemical investigation can determine their suitability for the purposes of road construction. In fact, so little is known of the properties which are required to make these materials valuable as binders for road surfaces that a good deal of chemical investigation is still necessary before satisfactory specifications can be drawn. Coal tars have been used sufficiently to indicate that to be of substantial benefit they must be partially refined and possibly combined with other materials. Unless all the water, the naphthas, some of the light oils and the ammoniacal liquors are removed, they will prove of little value. But the permissible specific gravity and percentage of free carbon, the proper viscosity and other characteristics are still undetermined. Even less is known of the asphaltic oils and asphalts than of the tars.

The specifications for bituminous materials which have been prepared for the Massachusetts Highway Commission are intended to represent the best materials so far offered. They are as follows:

"'*Refined Tar.*—The tar must be uniform in color, character, appearance and viscosity and must have the following qualities:

a. It shall contain not more than 0 5 per cent of mineral matter or dirt.

b. It shall have a specific gravity between 1.18 and 1.25.

c. It shall not contain more than 14 per cent by weight of free carbon.

d. It shall contain no body that distills at a lower temperature than 225 degrees C.; not over 10 per cent by weight shall distill below 270 degrees C., and it shall contain at least 65 per cent by weight of pitch or bituminous material remaining after all bodies have been distilled by heating up to 360 degrees C.

e. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C., the total loss shall not be more than 10 per cent by weight.

f. It shall be of such viscosity that 60 cubic centimetres measured at room temperature (78 degrees F. or 26 degrees C.) shall when at 100 degrees C. be not less than 85 seconds and not more than 240 seconds in passing through a viscosimeter orifice 5-64 inch in diameter when acting under a head of 4¼ inches.

g. When 12½ per cent by weight of the material is mixed with 87½ per cent by weight of sand, of such a grade that all will pass through a sieve having 10 meshes to the linear inch and practically none through a sieve with 190 meshes to the linear inch and briquettes made 3 inches square and ½ inch thick, such briquettes will so harden in seven days at ordinary room temperature that when laid flat and held by their edges by two parallel knife-edge bars, they shall not bend when a weight is suspended from a third knife-edge or parallel bar placed across their center until this weight reaches 200 grams and shall not break at less than 250 grams, and the weight causing bending shall not be greater than 80 per cent of the weight causing breaking.

"'*Asphaltic Oil.*—The oil submitted shall be of a uniform color, appearance, general character and viscosity, must contain no bodies not naturally present in an asphaltic oil, and must fulfil the following requirements:

a. It shall not contain more than 0.5 per cent of dirt or adventitious mineral matter.

b. It shall have a specific gravity of at least 0.97.

c. It shall not contain more than 1 per cent of matter insoluble in carbon bisulphide and should not contain more than 10.0 per cent insoluble in petroleum ether.

d. It shall contain no body that distills at a lower temperature than 250 degrees C., and shall not lose more than 55 per cent by weight by distillation to 360 degrees C.

e. It shall be of such viscosity that 60 cubic centimetres measured at room temperature (78 degrees F. or 26 degrees C.) shall when at 100 degrees C. be not less than 5 minutes nor more than 10 minutes in passing through a viscosimeter orifice 5-64 inch in diameter when acting under a head of 4¼ inches.

f. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C. it shall not lose more than 5 per cent by weight.

g. When 12½ per cent by weight of material is mixed with 87½ per cent by weight of sand and briquettes made 3 inches square and ½ inch thick, these briquettes must keep their shape and show some binding together..

"'*Oil Asphalt.*—*a.* The asphalt submitted shall be of uniform color, appearance and character, and shall contain no body not naturally present in an oil asphalt.

b. It shall not contain more than 1 per cent of dirt or adventitious mineral matter.

c. It shall have a specific gravity between 1.00 and 1.10.

d. It shall contain not more than 1 per cent of matter insoluble in carbon bisulphide and should not contain more than 30 per cent insoluble in petroleum ether.

e. It shall contain no body that will distill at a lower temperature than 225 degrees C. and should not lose more than 40 per cent by weight by distilling to 360 degrees C.

f. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C. the weight shall remain practically constant.'

"Of the three mentioned in these specifications, the tars are best known. Some excellent results have been secured by their use, and many failures have occurred. There is no doubt that a specification for the best tar composition will soon be available. As for the asphaltic oils and the oil asphalts, not so much can be said at the present time. They have not fully demonstrated their usefulness, in the Eastern States, at least, and they must be watched for a term of years. They give great promise, however. It must not be forgotten that it may cost less to resurface a road with an inferior material, often applied, than to use the new materials now entering into rural road construction. The cost per unit per annum is the ultimate test which shows the usefulness of any material."

CENTRALIZATION OF ELECTRIC POWER SUPPLY.

A DISCUSSION OF THE ECONOMIES OF CONCENTRATED MANAGEMENT AND LARGE PRODUCTION.

Louis A. Ferguson—American Institute of Electrical Engineers.

A FEW months ago we noted in these columns the extensive application of the policy of centralization in the generation of electric power in Germany, and the marked effects which are already apparent in the tendencies and progress of German industries. In the United States, where the tendency towards industrial consolidation is more pronounced than anywhere else, the advantages of centralization in electric-power production have somehow failed of general appreciation. That an awakening is at hand, however, is confidently predicted by Mr. Louis A. Ferguson, who took for the subject of his presidential address before the recent annual convention of the American Institute of Electrical Engineers the economies of concentrated management and large production in power supply.

"From whatever standpoint we view the problem," he says, "the advantages stand out boldly. The investor will be more favorably impressed with large issues of securities which require no detailed information. These securities will be easily marketed and on much more favorable terms than is possible with the smaller issues of individual companies. Large as this saving is, by far the most important one results from the economies effected by combined investment and output. The load-factor of our central stations, that is, the ratio of the average load to the maximum load, absolutely controls the earning capacity of the investment. The cost of generating and distributing electricity consists primarily of fixed charges on the investment and of operating costs. The fixed charges are independent of the hours use of the equipment; therefore, if the load continues heavy for long hours daily the fixed charges are distributed over a larger output and the cost per unit of output is thereby lessened. In other words, with long hours use a greater output follows, and greater earnings are produced without any increase in the investment. Obviously, therefore, the greater the proportion the fixed charges bear to the total cost the greater will be the effect of the load-factor. In modern large power systems, as is water-power plants, the operating costs are now so low that they represent a comparatively small part of the total costs, the fixed charges constituting by far the larger part. The importance of a good load-factor is thus apparent and everything that will improve this factor should be sought.

"The yearly load-factor for any one class of service is determined largely by the seasons, the habits of the people, and similar conditions which ordinarily do not change. Improvement in load-factor

must therefore be obtained largely by combining different classes of service, the maximum demands of which occur at different times of the day or of the year. Also, the larger the number of customers in any class the better will be the load-factor.

"The ratio between the sum of the maximum demands of various classes of service to the actual simultaneous maximum demand is termed the diversity factor, and the more non-coincident peak service that is combined in one system the greater will be this factor. It is here that centralization presents its most marked effect in increasing the load-factor and thereby the economy of production. The addition to a central station system of business having a high load-factor, such as power business for all-the-year-round service, amusement parks, auto charging and refrigeration for the summer, utilizing the otherwise idle investment, is desirable not only in itself but also because it reduces the cost of the entire output. The whole community through this reduction in cost is thus benefited by centralization, since the central station company is enabled to sell its product at a lower price to the small consumer because of the improved condition of manufacture effected by the supply of the large consumer.

"In the power station the larger output of combined loads will permit the use of large generating units which have a high performance efficiency, and which require a comparatively small operating force. This results in further reduction of costs. The investment per kilowatt, not only for the apparatus but for the land and building as well, is also less for large units, and the total reserve required by the centralized system will be but a small fraction of the combined reserve required where the load is furnished from individual systems. The saving in investment in this single item of reserve alone is an important factor in the problem. One of the leading causes for the success which has attended the development of the electrical industry in this country has been the standardization of equipment. Centralization leads toward standardization. In the present state of the art, generation will be by three-phase alternating current and the predominating demand will determine the frequency, be it 25 or 60 cycles or some other frequency. If, however, the demand in any community for an auxiliary standard frequency becomes sufficiently large even though it remain a small part of the total output, then generation at this auxiliary frequency is justified; but connecting links of ample capacity should be provided between the sets of generators of different frequency so that the advantages of the diversity factor and of common reserve may still obtain. The voltage should also be so chosen that the transmission cable may be interchangeable between the two systems.

"An incidental advantage of centralization, which, however, is of great sociologic importance in a community, is the resultant cleanliness due to the absence of countless smoking chimneys. This fact is being actively recognized by civic improvement bodies and such recognition is a valuable asset to a central station company in the prosecution of its industrial power campaign."

Mr. Ferguson refers briefly to the success of certain large power companies which have put the principle of centralization into practice. As striking examples he mentions the Newcastle-upon-Tyne Electric Supply Company and the Pacific Gas and Electric Company. At Niagara the full benefits of centralization will be realized when the stations are loaded up to the point where they will be compelled to arrange for interchange of energy. A vigorous start towards centralization of power production has already been made in Chicago.

"In a large number of cities two prominent public services, street railways and electric lighting, were originally inaugurated by one company, and with the natural growth and development of the two systems the electrical generation has in many cases been unified so that one set of generators furnishes energy for both railway and lighting. However, in most of these

cities the industrial power business has not been vigorously developed either because of lack of appreciation of its value or timidity on the part of the supply company in making sufficiently low prices to obtain the business.

"There are also very few, if any, communities or territories in which the centralization of power supply for all purposes has been effected and in which electric power is utilized in such manner that the best economic results are realized. By combining all systems of neighboring cities within a radius of 30 or 40 miles into a single centralized system a great saving in production would result and in most cases an improvement in service as well. The utilization of water powers will help in this direction.

"The monopolistic character of the electric power industry is now being recognized by the intelligent public and monopoly privileges with proper regulation are being granted as the best safeguard for the interests of the people. The legal way is thus being paved for the beginning of centralization. Such centralization will naturally include the power for electrified steam railways, the universal coming of which is but a matter of time. In most instances the total amount of power required by a railroad for its terminal and suburban service, even where counted in the tens of thousands of kilowatts, is but a small part of the total power required for all purposes within the same area. If this railroad power is generated in a separate plant the load-factor would be far below that of the central station and the necessary reserve capacity would require a high fixed charge to be carried by the plant. With less reserve the reliability of the service might suffer disastrously. No railroad could thus generate its own power as cheaply or as securely as it may be purchased from a properly directed central station company. This applies also and to an even greater extent to power production for industrial uses or to individual generation for any purpose.

"In cities where the power production is not centralized, a multiplicity of systems of voltages and often of frequencies is usually found, and the duplication which spells waste is abundant. Without the economies resulting from centralization the price of the output will necessarily remain higher than otherwise and the community must pay the cost. With the lower efficiency of generation the fuel resources are wasted and the entire country will ultimately suffer as a result.

"There is scarcely any branch of the electrical industry which does not ultimately affect or which is not in a measure affected by this development. The progressive work of the electrical engineer will deterimne with what success we can reach out into these larger fields. The mechanical engineer has given us a steam turbine of greatly improved economy; it is for us to improve still more the method of transmission and conversion and the application of electricity in the arts. High-voltage transmission made possible our entry into this field, but, while very great advances have been made, there are still some unsolved problems in this field and particularly with regard to underground transmission. There are also many problems and countless opportunities in connection with the utilization of electrical energy. The successful solution of these problems is of the utmost importance. It is for the commercial electrical engineer (which really includes nearly all of us) to educate the layman and particularly the power user to an appreciation of the superiority and desirability of electric service and to emphasize the material and ethical advantages to a community of centralized power production. It is for the technical electrical engineer to furnish him with the sinews of war, with the ammunition to conquer in the fields where waste, where useless dissipation of energy prevails. We should bend every effort to advance the cause of centralization with its resultant economic gains. Those connected with the manufacturing interests especially should not tolerate for an instant a selfish backward step within their fold."

THE SPONTANEOUS HEATING OF COAL.

A SUMMARY OF THE CAUSES AND METHODS OF PREVENTION OF SPONTANEOUS COAL FIRES ON SHIPBOARD.

Richard Threlfall—Society of Chemical Industry.

TROUBLESOME and disastrous fires on board ship caused by the spontaneous heating and combustion of coal cargoes are much less frequent than they used to be, but, as Mr. Richard Threlfall points out in a recent paper before the Society of Chemical Industry, with our present knowledge of the subject there should be no heating of cargoes at all. The causes of coal fires have been clearly shown by a number of important investigations, and it has been amply demonstrated that comparatively simple precautions are all that is necessary for their prevention. There is plenty of evidence to support Fayol's conclusion that there is a direct relation between the liability to spontaneous heating and the height and volume of the heap in which it occurs. If the heap is small, the temperature rises to a certain point, after which it becomes stationary, and then falls again. Coal cargoes seldom or never fire through the action of pyrites. Liability to spontaneous combustion depends on the size of the ship, the size of the heap of dust under the hatchways, the system of ventilation, the loading temperature of the coal, and the amount of breakage which occurs during shipment.

The larger the cargo, the larger and deeper the ship; consequently, the percentage breakage on loading will increase with the size of the ship, and the size of the heap of dust under the hatchways will vary as the fourth power of the linear dimensions of similar ships. The statistics collected by the Commission of 1876 demonstrated to a startling extent that the proportion of casualties traceable to spontaneous combustion increases directly with the tonnage of the cargoes. The heap of dust under the hatchways is by far the most dangerous place. In fact, the New South Wales Commission failed to find a single undoubted case of spontaneous fire having originated in any other place. Ventilation of the cargo can do little to remove the danger. It was formerly the practice to ventilate coal cargoes by means of air trunks running along the bottom of the ship below the coal. Air was supplied to this system by more or less elaborate vertical shafts, and escaped into the cargo by lateral openings so as to distribute itself through the coal. The Commission of 1876 proved that by this system of ventilation the carriage of coal was made more dangerous.

The New South Wales Commission of 1896 established the fact that the risk of spontaneous fire is much greater when the cargo is loaded in summer than it is when the cargo is loaded in winter. Experiments on a large heap of slack showed that at the depth of from 3 to 4 inches from the surface, coal exposed to the sun reached a temperature from 20 degrees to 40 degrees F. beyond the recorded maximum shade temperature. Breakage during shipment has long been recognised as a possible contributing factor to spontaneous combustion and the Commission of 1876 devoted much time to the investigation of systems of loading. They could only point out that all systems gave rise to breakage. Since that time immense improvements in shipping methods have been brought about, but there is still need for the development of a less expensive system than those to which most of the improvement is attributable.

"No account of spontaneous heating of coal on board ship would be complete without a reference to the subject of gas explosions. An explosion is often a consequence of spontaneous heating of a cargo of coal, and is sometimes the first indication a captain gets that his cargo has heated. The cause, of course, is the low temperature distillation going on at, and around, the centre of heating, and

the gas generated is usually almost or quite colourless. In one case the scent of the gas was between that of benzene and paraffin oil—an odour which is easily recognisable once it has been smelt—it is not at all like that of town gas. As heating progresses the distillation products become visible, and in this case an actual outbreak of fire can only be a matter of a few hours. Carbon monoxide is probably always a constituent of the gas evolved from the hot coal and cases of poisoning have been reported. The gases coming from a spontaneous fire in a mine examined showed 0.2 per cent. CO—a quantity which could not be breathed with impunity for more than a short time, say, half an hour. The danger of explosion has in the past been aggravated by the habit of battening down when a smell of gas is first perceived, in the hope of cutting off all access of air to the cargo. Having in view the fact that the explosion of weak mixtures probably gives rise to pressures of less than 100 pounds per square inch (Mond gas uncompressed is said to have a maximum explosion pressure of 60 to 70 pounds per square inch), it is wonderful what destruction can be brought about on ship board by such explosions. On the whole, if the cargo heats, it is better to be sure that the surface ventilation is adequate by removing the hatches, than to try to keep all the air from the coal, though, of course, if the hatches could really be made air-tight the fire would eventually go out.

"The second New South Wales Commission made the following recommendation: 'Having in view the fact that cases of spontaneous heating invariably occur in the heap of small coal under the hatchways, and in the light of the foregoing conclusive result, we recommend that where large ships are being loaded during warm weather (say, when the temperature of the air is 90 degrees F., or over) a hose should be played down the hatchway so as to wet, at all events, the coal which collects at that spot.' This recommendation was made with full knowledge of the theory of the matter and with the results of a large, costly and conclusive experiment before the Commissioners; and everything goes to show that a cargo thus treated would be absolutely safe, if not for ever, still for a much longer period than is occupied by any ordinary voyage. At Cardiff it is not unusual to spray the coal during loading, in exceptionally dry weather, to lay the dust a little—a system good so far as it goes, but one which gives no security that the dangerous part of the cargo under the hatches is really wet enough. Statistics show that from one cause or another spontaneous fires on board ship are now much less frequent than they used to be, but with our present knowledge of the subject there should be no spontaneous heating of cargoes at all. The means to be adopted are simple. In the first place if the weather is cold during the time the coal is in transit, and being loaded, no special precautions appear to be necessary except in regard to surface ventilation. If the weather is warm, and particularly if it is sunny, and if the coal has been lying in trucks exposed to the sun, the heap of small coal and dust under the hatchways should be attended to. One way would be to dig out the heap under the hatchways and distribute the coal over the rest of the cargo, replacing it by larger coal, as has occasionally been done. The objection to this would be the cost. From measurement of some drawings, it is estimated that about one-fifteenth of the cargo might have to be retrimmed. If we consider a cargo of 2,000 tons, this means the restowing of about 130 tons. This could not cost more than about 6d. per ton for labour, or £3 5s., to which would be added possible charges for demurrage. Instead of delaying a ship under the cranes or tips (which would have the advantage that when the hatches were dug out the holes could be filled in direct from the loading appliances), it might be preferred to do the filling in from the rest of the cargo, though this could hardly be done conveniently if the ship was well loaded. In this case the labour charge would be higher, perhaps double the figure given above. A more certain and less labori-

ous precaution would be the adoption of the recommendation of the second New South Wales Commission to wet the heap of fines under the hatchway. Such a mixture is thoroughly wetted if it carries 10 per cent. of water. The coal probably would carry 2 or 3 per cent. of water on an average in any case, so we may reckon that about one-fifteenth of the cargo would have to carry 8 per cent. excess water. This is an increase of weight of about ½ per cent. calculated on the whole cargo, and the estimate is probably above, rather than under the mark. As to the means of carrying out the distribution of water, it would be a simple matter to arrange a Koerting's spray nozzle to play down the hatchway during the loading, and the delivery of water could be easily adjusted till the coal was observed to be thoroughly wetted where it needed to be wet. A still simpler plan would be to finish the trimming by leaving a depression in the surface of the cargo under the hatchways and pouring in water—salt or fresh—till the calculated amount, up to ½ per cent. of the weight of the cargo, but possibly only ¼ per cent., had been added and allowed to soak down."

MARINE TURBINE PROPULSION AT MODERATE SPEEDS.

SUGGESTED MEANS OF IMPROVING STEAM ECONOMY AND PROPELLER EFFICIENCY IN TURBINE DRIVEN VESSELS.

Yasuzo Wadagaki—North-East Coast Institution of Engineers and Shipbuilders.

WHATEVER may be thought of the practicability of the means suggested for improving the steam economy and propeller efficiency in turbine-driven vessels, the proposals of Mr. Yasuzo Wadagaki in his recent paper before the North-East Coast Institution of Engineers and Shipbuilders, published in the *Transactions* for July, possess at least the merit of novelty. The first is nothing less than the utilization of the energy in the exhaust steam from the main engines or turbines to compress the main supply of live steam before it is admitted to the cylinders or turbines. The second proposal is that the propeller should be put in a tube, a suggestion which has been made many times before, but never on quite the same theory as Mr. Wadagaki's. Special interest attaches to this part of his paper and we devote to it the greater part of the following review.

After brief reference to various methods which have been suggested for overcoming the speed difficulty, the use of mechanical gearing between turbine and propeller shaft, the electrical transmission system, the Parsons plan of using turbines in series with reciprocating engines, and the use of the electrical transmission system with low-pressure turbines, Mr. Wadagaki introduces his own novel suggestion. "A further method," he says, "is one in which the residual available energy in the exhaust steam from the main propelling engines or turbines is used for driving an auxiliary turbine having no direct mechanical connection with the propeller shafting, but coupled directly with a rotary steam compressor of suitable design, so arranged as to compress the main supply of live steam from the boilers to a still higher temperature and pressure, before it is admitted to the main cylinders or turbines.

"The principles upon which this idea is based may be explained as follows: In marine engines generally, the expansion of steam in the engine cylinders cannot be carried so far as might be desired, simply because marine engines have to develop the highest possible amount of power per ton weight. On the other hand, if, at the expense of extra weight, the engine cylinders were made large enough to give the desired ratio of steam expansion, then the loss due to initial condensation in the engine cylinders and the mechanical friction of the engines, when working at a reduced power, would discount any advantage arising from the greater expansion of

the steam. Again, in the case of vessels fitted with turbine engines and cruising at a moderate speed, the propelling turbines cannot be made to work at a sufficiently high number of revolutions per minute; for the inevitable consequence of using too small a propeller would be a serious decrease of propulsive efficiency at full speed. In all these cases, a large amount of otherwise available heat is unavoidably carried away with the exhaust steam. But the arrangement suggested above would lead to a saving of at least part of this large waste of energy by virtue of the auxiliary turbine and the rotary steam compressor introduced into the system. As already stated, this auxiliary turbine and the rotary steam compressor have no direct mechanical connection with the propeller shafting, so that they can be operated at any desired speed without affecting in any way the efficiency of the screw propeller. Thus the maximum amount of the energy still left in the steam at the last stage of its expansion can be saved and restored to the main supply of live steam in the shape of increased pressure or temperature or both. This system involves no mechanical losses, except that due to friction of the shaft bearings. On the other hand, its adoption would give all the advantages of superheated steam practically at no extra cost in power. The result would be a considerable improvement in the steam economy of the main propelling engines or turbines."

Mr. Wadagaki has been studying for years the problem of devising a system of screw propellers capable of being operated at different speeds without corresponding loss of efficiency. The method he has finally arrived at is to use "a metallic pipe or casing surrounding the screw propeller, the forward and aft ends of which are flared into bell-mouth shape with a cross section area gradually contracting from the two ends towards the screw propeller. The particles of water flowing along the ship's bottom enter the propeller casing at its forward end with a relative velocity almost equal to the forward speed of the vessel. As the cross section area of the channel is gradually contracted toward the screw propeller, the velocity of water is correspondingly accelerated in inverse ratio until, at the most contracted part of the channel, the velocity rises to a maximum. And it is here that the water is acted upon by the screw propeller. Thus the propeller is enabled to operate in water having a relative velocity much higher than the forward speed of the vessel. After passing through this contracted part of the casing, the water comes to a gradually expanding part of the channel in the after body of the casing, with its velocity correspondingly reduced. The area of the cross section of the casing is made slightly less at the outlet than at the inlet end. The velocity of water at the outlet is therefore slightly higher than it is at the inlet. This difference in the velocity of water at the forward and after ends of the propeller casing represents therefore the amount of true slip imparted to the water." Mr. Wadagaki has demonstrated that by suitably supporting the propeller casing it can be made to act as a rudder. In this case the shaft would have to be supported directly by the ship's structure; with a rigid casing the shaft would be supported by a bearing connected to the casing itself.

"There are many advantages resulting from the use of the proposed system of marine propulsion which tend to increase the propulsive efficiency. For any ship steaming at any given rate of speed, the amount of slip depends upon the quantity of water acted upon by the screw propeller per unit of time. In the proposed system of screw propulsion, the flow of water to the propeller is accelerated to a speed much higher than the forward speed of the vessel. Therefore the quantity of water acted upon by the screw per unit of time is much larger than if the same screw were working in free water. Hence a smaller amount of loss due to slip is entailed in the efficiency of the screw propeller, and the higher number of revolutions that can be maintained without causing a serious loss to the propulsive efficiency

enables the steam turbine to work with greater economy.

"The final velocity of water discharged from the propeller casing simply depends upon the sectional area of the after end of the water channel, so that the slip of the screw can to some extent be controlled and kept within an economical limit, for any reasonable number of revolutions per minute; and even when the revolutions become so high as to cause a partial cavitation, the diminution of the water pressure acting on the forward side of the contracted water channel would indirectly increase the forward thrust on the propeller casing, thus restoring a part of the energy that might have been entirely lost otherwise.

"With the ordinary arrangement of the screw propeller, the power required to produce the transverse motion of water particles is usually wasted in the screw race. But in the proposed system the centrifugal force imparted to the water is usefully converted into a forward thrust by virtue of the increased pressure of water acting on the divergent side of the discharge end of the casing. For any ship steaming at any given speed, this system of propulsion requires less weight of propelling machinery, because the propeller can efficiently run at a higher number of revolutions than with the ordinary arrangement. One obvious drawback to the system is the increased resistance of water arising from the surface friction of the propeller casing, both inside and outside. There is good reason, however, to believe that the loss from this cause would be amply compensated for by the hydrodynamic gains which have already been explained."

Mr. Wadagaki presents in support of his conclusions a large number of data obtained in experiments made some time ago at the Imperial Naval Dockyard at Sasebo, Japan. The trials were made in a tank round which the water could move; the power of the propeller was absorbed by the frictional resistance of water against the sides and by its deflection at the ends of the tank. "The screw propeller used in these experiments was 8 inches in diameter with a uniform pitch of 10¼ inches. It was made with three blades, their total expanded area being just about 30 square inches. The casing within which the screw propeller was arranged to operate had the inlet diameter of 13½ inches and the outlet diameter of 11½ inches. The diameter of the propeller casing at the most contracted part of water channel was 9 inches, leaving a clearance of one-half inch over the tips of the blades. The length of fore body of the propeller casing was 5 inches, the shape of the inlet end of the water channel approximating to the natural form of the contracted vein. The after body of the propeller casing was 15 inches long, with an expanding channel of easy form. The total length of the propeller casing was thus 20 inches." In most of the trials an electric motor was used for driving the propeller, but a few experiments were made with a small steam turbine. In each case the power delivered to the propeller shaft and the revolutions of the propeller were carefully measured. The thrust of the propeller was taken by a thrust collar on the shaft and measured by means of a spring balance. The propeller casing was carried on a horizontal rail with anti-friction rollers. The thrust upon the propeller casing was indicated and recorded separately from that exerted upon the propeller shaft, by the compression of a steel spiral spring fitted upon the rail carrying the casing.

Trials were made with and without the casing. From the results Mr. Wadagaki makes the following general deductions: "(1) that with a propeller casing working in combination with a screw propeller, the indirect thrust on the propeller casing is a little over one-third of the total thrust; (2) that the total thrust obtainable with such a system of screw propulsion is about 11 per cent. more than would be the case if the same screw had operated in free water at the same expenditure of power; (3) that for any given ship steaming at any given speed, the use of such casing round the pro-

peller would admit of the latter working at about 11 per cent. more revolutions than if the same propeller worked in free water; (4) that the increased number of revolutions of the propeller fitted with this kind of casing would enable the steam turbine which drives it to develop proportionately more horse power than with a free propeller with the same consumption of steam."

The figures for all the experiments were quite consistent. We have space for only one or two examples. With the casing not in use, the thrust was 38.6 pounds at 800 revolutions; at 1,245 revolutions it was 78.7 pounds. With the casing, at 850 revolutions, the propeller thrust was 22 pounds and the casing thrust 7.4 pounds, a total of 29.4 pounds. At 1,240 revolutions the casing thrust was 28 pounds, while the propeller thrust was 49.3, or in all 77.3 pounds. At first sight these figures show a loss instead of a gain, but whereas the watts required to give a thrust of 78.7 pounds without the casing were 3,168, with the casing only 2,535 watts were required to give a thrust of 77.3 pounds.

THE COMMERCIAL PRODUCTION OF OXYGEN.

A DESCRIPTION OF THE METHOD OF ITS MANUFACTURE FROM LIQUID AIR.

Cecil Lightfoot—The Electric Journal.

INDUSTRIAL oxygen, for use in autogenous welding or for other purposes, may be produced by any one of three methods, by the electrolysis of water, by chemical reaction, or from liquid air. The electrolytic process has not been developed commercially to any great extent, and the chemical process is the one most widely in use. Extraction from liquid air requires a considerable amount of expensive machinery, but, once started, the process is practically automatic and for large outputs is the most economical of the three. A description of the apparatus required for the liquefaction of air, by the well-known method of von Linde, and for the separation of the nitrogen and oxygen, is taken from a paper by Cecil Lightfoot in *The Electric Journal* for September.

"The action of the Linde machine for air liquefaction is based on the refrigerating effect resulting from the expansion of air from a higher to a lower pressure, and which is due to the performance of internal work. At ordinary temperatures, this reduction in temperature amounts to about three-tenths degree C. for each atmosphere of difference in pressure. It is, therefore, too insignificant to produce liquefaction of air at a single expansion, since this only takes place below —140 degrees C, (critical temperature of air) and at —191 degrees C. at atmospheric pressure, this being the boiling point of liquid air.

"In the Linde machine the action of any desired number of expansions is accumulated and intensified by causing each preceding expansion to act as a fore-cooler to the air for the following expansion. This is attained by adopting the principle of heat interchange, which is, in this case, most efficiently applied by employing concentric tubes placed one inside the other and coiled in spiral form. The compressed air flows from top to bottom through the inner tube of the vertical double coil, expands through a valve between the inner and outer tubes from the bottom to the top, transmitting the cooling effect produced by expansion to the compressed air flowing down the inner tube. As a result the temperatures of the air before and after expansion are continuously reduced to the temperature of liquefaction, and part of the expanding air will collect in the liquid state in a vessel situated at the lower end of the heat-interchanger.

"As the refrigerative action of the apparatus depends upon the difference of pressure before and after expansion, while the work of compression corresponds to the ratios of these pressures, the advantage of selecting a large difference in pressures, but a small ratio of pressures is apparent. In the machine

herein described, the greater part of the cooling effect is produced by the expansion of air at an initial pressure of about 200 atmospheres to a pressure of 20 to 50 atmospheres, so that, according to the size of the machine, the difference of pressure is about 150 to 180 atmospheres, while the value of the ratio varies approximately from four to ten. Only the small quantity of air requisite for the primary charge and its subsequent renewal is introduced into the cycle from the surrounding atmosphere, leaving it again partly as liquid and partly as gas at atmospheric pressure.

"The Linde machine for the liquefaction of air consists of the following parts: the heat-interchanger; the air-compressing plant; and appliances for the preliminary cooling and drying of the compressed air. The heat-interchanger consists of a triple coil composed of copper tubes placed one within the other. The cycle for air is performed, as already described, by causing air compressed to 200 atmospheres to flow downward through the innermost coil, at the lower extremity of which it is allowed to expand to an intermediate pressure of 20 to 50 atmospheres. The expanded air is then returned through the annular space between the innermost and middle coils to the top of the interchanger, when it is again compressed up to 200 atmospheres pressure and the cycle is repeated. By means of regulating valves, when the operation of the machine has been brought to a state of equilibrium, a small quantity of air is allowed to escape at atmospheric pressure, a corresponding amount being introduced into the cycle from the surrounding atmosphere. Part of this air leaves the second regulating valve in the liquid-air state and is collected in a vessel; the remaining portion is returned to the atmosphere through the annular space between the middle and outer coils. The liquid air is drawn from the collector by means of a small cock.

"In the larger installations the necessary compression of the air is effected by means of a high-pressure air pump, which is usually arranged for two-stage compression, working in conjunction with a single-cylinder low-pressure air pump. The high-pressure cylinder of the former draws the partly expanded air from the heat-interchanger at an intermediate pressure of about 50 atmospheres, and compressing it up to about 200 atmospheres pressure, delivers it to the interchanger again, through a cooler. The air which is to be added to the cycle as 'make-up' is supplied by a low-pressure air pump, which draws it from the atmosphere, compresses it to a pressure of about four atmospheres, and delivers it to the low-pressure cylinder of the high-pressure air pump, where it is compressed to a pressure of about 50 atmospheres. At this pressure it enters the high-pressure cylinder, together with the partly expanded air from the heat-interchanger. Regulation of the several pressures is performed with the aid of pressure gauges by means of the regulating valves in the heat-interchanger. Safety valves are provided to prevent the maximum pressures being exceeded.

"The duty of air-liquefying plants is considerably augmented by a preliminary cooling of the compressed air prior to its entering the heat-interchanger. For this purpose a fore-cooler is provided, by means of which the compressed air is reduced in temperature to —12 or —15 degrees C. by filling the receptacle provided for the purpose with a suitable freezing mixture, such as ice and salt. With larger installations, the preliminary cooling is brought about by a small belt-driven refrigerating machine on the ammonia compression system. The adoption of fore-cooling is advisable in all cases, but especially when the cost of power is an item of great importance. Between the compressor and the fore-cooler, apparatus is provided for separating water from the compressed air. This apparatus is provided with a suitable drain cock. Further extraction of the aqueous vapors from the compressed air in the smaller installations is effected after the last stage of compression by means of chloride of calcium.

"The principle of the Linde apparatus for the production of oxygen from the

atmosphere consists first of all in the complete liquefaction of the air to be resolved. The liquid air thus obtained is then passed through an interchanger, in which it acquires the necessary latent heat of evaporation by assisting in the liquefaction of a further supply of air, and is then subjected to a process of rectification. This rectification, which is very similar to the process employed in spirit refineries for the separation of alcohol and water, enables oxygen having a purity of 95 per cent to be delivered from the apparatus. If the output be reduced by 10 to 20 per cent, the quality of the oxygen produced may be brought up to as high a degree of purity as 98 or 99 per cent.

"The interchange of heat which takes place in the apparatus is so complete that before the by-product nitrogen is returned to the atmosphere so much heat has been removed from the incoming air that it leaves the bottom of the fore-cooler at a temperature considerably below freezing point, and then enters the top of the separator, passing downward through a series of coils, which are so constructed as to be surrounded by both the outgoing cold gases, i. e., both oxygen and nitrogen. The bottom of the separator contains liquid air, or more correctly speaking, liquid oxygen. The compressed air, on its way to the expansion point, is conveyed through this liquid, by which means it is largely condensed. It then passes through a regulating valve, at which point it expands, and it is ultimately discharged into the top of an inner central chamber which forms the rectifying column in which the separation of oxygen and nitrogen is effected, oxygen descending in a liquid state to the bottom of the separator, and nitrogen ascending in a gaseous or vaporous condition to the top. The nitrogen is allowed to discharge freely into the atmosphere through an extension of the fore-cooler, and the oxygen is allowed to boil off in any desired quantity by the adjustment of an oxygen discharge-valve. Both gases, however, as already stated, on leaving the separator are kept in intimate contact with the coils conveying the incoming air, so that before leaving the apparatus the heat of the incoming air has been mostly transferred to the gases. It will thus be seen that after equilibrium has been attained, the process is practically automatic."

THE TESTING OF ZINC PROTECTIVE COATINGS.

A DISCUSSION OF METHODS OF DETERMINING THE RESISTANCE TO CORROSION OF GALVANIZED AND SHERARDIZED IRON.

Wm. H. Walker—American Society for Testing Materials.

IN the May number of this Magazine, Prof. Wm. H. Walker has discussed the causes of the corrosion of iron and steel, and has pointed out the function of zinc coatings in its prevention. A subsequent paper by the same author, read before the American Society for Testing Materials, is devoted to a consideration of methods of testing the durability of zinc protective coatings produced by the various processes in commercial use, based on Prof. Walker's own researches. As an interesting supplement to his contribution to our pages, we give his conclusions below.

Three processes are now in commercial use for coating iron with zinc: "hot galvanizing," in which the iron or steel article is simply dipped into a bath of molten zinc; "wet galvanizing," in which metallic zinc is deposited upon an iron plate from an aqueous solution of a suitable zinc salt by means of an electric current; and "sherardizing," in which the iron article is heated in a closed chamber in the presence of finely divided zinc and zinc oxide. Although there is a marked difference in appearance and structure between zinc coatings produced by these three methods, only one method has been used for testing them, the Preece copper-sulphate immersion test. A standard solution of copper sulphate, prepared by agitating a

nearly saturated solution of this salt with copper oxide until it is perfectly neutral, is diluted to 1.186 specific gravity at 65 degrees F. When zinc and iron are immersed in this solution, these metals are dissolved and copper plates out in their place; on the zinc surface, the deposited copper is black, spongy and easily removed, while on the iron it is dense and of a bright color. When this reaction is used in testing galvanized iron, it is assumed that the speed of solution of the zinc is a direct function of the time of immersion, and that from the number of one-minute immersions necessary to dissolve the zinc from the iron and to deposit a film of bright copper thereon, the thickness of the zinc can be estimated. The assumption is also made that no bright copper will be deposited until the copper sulphate reaches the pure iron base.

The limitations of this test are apparent when we consider the structure of the three classes of zinc-coated iron. Hot-galvanized iron consists of three distinct layers: first, a coating of zinc, which varies in thickness according to the temperature of application and the treatment of the article before the zinc solidifies; second, an iron-zinc alloy, termed Alloy B, which varies in thickness according to the temperature of the zinc bath and the time of immersion; and third, the iron base itself. Between the pure zinc and Alloy B, and between Alloy B and the iron base, thin layers of two other alloys are usually found, termed, respectively, Alloy A and Alloy C, the former being richer in zinc, and the latter richer in iron, than Alloy B. The structure of wet-galvanized iron is comparatively simple, the layer being practically pure zinc. Sherardized iron presents a complex structure. Frequently no layer of pure zinc is found and the place of Alloy A is taken by a number of compounds not yet identified. Deep layers of Alloys B and C are always formed. The surface shows under the microscope deep cracks and fissures as though the alloy in forming had contracted. It is apparent that in testing galvanized iron made by these different processes we are dealing with three very different materials.

A test of the durability or resistance to corrosion of zinc-coated iron should indicate the following: (1) the uniformity and thickness of the zinc coating; (2) the continuity of the coating with reference to pin holes; (3) the purity of the zinc; and (4) the toughness and ductility of the coating.

"To determine whether the ratio of the time of immersion required to produce a bright copper surface was in reality a measure of the thickness of the zinc coating, samples of galvanized sheets were obtained and tested. The weight of zinc per square inch area was determined by dissolving the zinc from the sheets without attacking the zinc-iron alloy. This can readily be accomplished by heating the galvanized sample together with a piece of metallic iron in boiling caustic soda until the generation of hydrogen ceases. As might be expected, the ratio between the time of immersion required to show the presence of bright adherent copper and the amount of zinc present per unit area, depends upon the uniformity with which the coating of zinc is spread upon the iron base. In the case of 14 pieces of galvanized sheet iron, for example, the average ratio found was 23, while the greatest variation in either direction was but 20. This test, therefore, so far as indicating the uniformity of the coating and measuring the thickness of the zinc are concerned, is fairly satisfactory; but Alloy B is always indicated as iron, and hence, when the test is applied to sherardized articles, very erroneous and misleading results may be obtained.

"The presence of the channels or pin holes caused by the free iron surface coming in contact with the zinc and causing it to pass into solution cannot be detected by the copper-sulphate method, as these pin holes down through the zinc to the iron fill up with black, spongy copper which covers up the bright copper spot at the bottom. The purity of the zinc cannot be determined, as the bright copper particles precipitated by this method are so small that they are

lost in the mass of black, spongy copper. Finally, the fourth factor, the toughness or the ductility of the coating, cannot be determined, due to the same tendency of the spongy copper to cover up the bright copper deposits, which indicate cracks extending down through the zinc coating to the alloy or iron underneath.

"The relation between the presence of pin holes in the zinc surface and cracks due to a brittle coating, and the durability of the structure as a whole, has not heretofore been studied, largely because no method of detecting these imperfections has been available. The following phenomenon serves as a basis for such a test. If a piece of zinc be placed in a strong solution of caustic soda heated to about 100 degrees C., no action is noticeable. If now the zinc be touched with a piece of iron, hydrogen is liberated in great volume from the iron. Small cracks in the zinc coating may be easily detected in the same way.

"Ordinary hot-galvanized ware is generally very free from imperfections of this kind, while wet-galvanized ware, on the other hand, is frequently very porous, generating hydrogen at numberless small points over its entire surface. Theoretically, the best electroplated surface should be that carrying the greatest weight of zinc per unit area, deposited at the slowest rate. That is, the lower the current density at the cathode in plating, the less porous will be the deposited metal, and the thicker this dense deposit is, the better protection will it be. A great many tests on electroplated zinc-coated iron were made, the samples varying in both these particulars. In every case those deposited most rapidly were the most porous, and the results showed that the time of plating was more important than the weight of zinc per unit area, although there was a minimum thickness of coating below which it was not safe to go.

"As the rapidity of hydrogen generation from zinc is a function of the presence of an alloy of zinc and iron, hence the more impure the zinc coating, the more impure will be its solution in acid. Accordingly, the impurity of the zinc, the presence of pin holes and cracks and the thinness of coating are all factors which act in an accumulative way to increase the rate at which hydrogen is generated when the zinc surface is exposed to acid. This method has been found to give very concordant results. The apparatus employed may take any convenient form, it being but necessary to expose a known area of the zinc coating to a standard acid solution under uniform conditions and to measure the hydrogen generated per minute. In almost every case a sharp maximum is reached giving the resultant of all the different factors which make for rapid dissolution of the zinc. Thus in a series of wet-galvanized sheets, those electroplated for 15 minutes reached a maximum of 7 cubic centimetres in three minutes; those plated for 30 minutes a maximum of 14 cubic centimetres in 10 minutes, while those plated for 45 minutes showed a rather poor maximum of 6 cubic centimetres in 30 minutes. In many samples of sherardized product there were two maxima on the curve showing the amount of hydrogen generated per minute. This indicates that there is first an action between the outside zinc coating and the iron-zinc alloy, and later a well defined action between the alloy and the iron.

"Service tests with galvanized iron are of necessity very slow at best, and the relation of the above phenomenon to the real durability of the material can be determined only after a number of years. Something can, however, be learned by the study of ware which has already been exposed for sufficient time to determine its durability. Most of the material available for the purpose was in the form of fence wire; from a study of numerous samples of wire the following conclusions are drawn:

"1. Thickness of coating.—In every instance where a very durable fence was found, the coating of zinc proved to be relatively very thick. On the other hand, the wire fences which showed marked corrosion in from one to two years proved to have almost no zinc on the iron, the zinc color being due to a layer

of alloy alone. It is doubtless true that the purity of the iron used in the wire itself plays an important part in determining the ultimate durability of a fence, yet in the opinion of the writer the thickness of the zinc coating calls for more immediate attention. The modern method of close mechanical wiping the wire as it emerges from the zinc bath, produces too often a wire covered not with zinc, but only a thin layer of electro-negative iron-zinc alloy, which affords but little protection to the iron. To produce a wire with a liberal coating of zinc would, of course, cost more both on account of the extra zinc and on account of a somewhat smaller production of wire per machine.

"2. Purity of Zinc.—It is probably a necessary consequence of hot galvanizing that the zinc becomes somewhat contaminated with dissolved iron. It is apparent that this should be kept at a minimum and the zinc be kept as pure as possible in order that the coating should be of maximum durability.

"3. Flexibility of the Zinc Coating.—The important objection to placing a thick coating of zinc upon wire used for fencing is that such a coating cracks off when running through the finishing machines. This objection applies only to those wires which are subjected to very sharp bends or turns. It is possible that by subsequent treatment, such as passing the zinc-coated wire through dies or under grooved rolls, the crystalline condition of the zinc could be destroyed and the flexibility and ductility of the coating materially increased."

A STATION FOR THE INVESTIGATION OF DUST EXPLOSIONS.

A DESCRIPTION OF THE PLANT OF THE COMITÉ CENTRAL DES HOUILLÈRES DE FRANCE AT LIÉVIN.

M. J. Taffanel—Revue de Métallurgie.

PREVIOUS to the Courrières disaster in March, 1906, dust explosions in French collieries were practically unknown. Intelligent regulations for the prevention of accumulations of gas, the use of safety lamps and the employment of safety explosives had given France an enviable immunity from mine disasters of a serious character. The Courrières, however, showed the existence of a danger for which no provision had been made and indicated that if similar explosions were to be prevented, the causes and laws of propagation of dust explosions would have to be investigated. The work was taken up by the Comité Central des Houillères de France, who in 1908 erected, at the cost of $70,000, an elaborate experiment station at Liévin, which it is the purpose of this review briefly to describe, after an article by M. J. Taffanel in the *Revue de Métallurgie* for July.

The station has a sixfold purpose: to study the inflammability of coal dust, the conditions of propagation of flame in a dust-laden atmosphere, and methods of combatting the dust danger; to study and control the safety of mining explosives in the presence of gas and dust, and blasting methods and appliances; to study and control the safety of mine lamps and electrical appliances; to investigate rescue appliances; to constitute a laboratory for research on all problems relating to safety in mines; and to prosecute inquiries abroad, particularly after mine disasters. The equipment comprises one main and one auxiliary experimenting gallery; a building for offices, laboratory and machinery; a coal-crushing plant; a building for coal storage; two firedamp gasometers; and a dwelling for the guardian.

As originally built, the main experimental gallery was 65 metres long. It is now being extended to a length of 500 metres. Reinforced concrete is employed in the construction of 30 metres of the original section. The remaining 35 metres is built of various materials, with a view to determining their suitability for the contemplated extension. The walls of the reinforced concrete section

are 18 to 22 centimetres thick. Transverse reinforcement, consisting of 6 steel bars 30 millimetres in diameter and 3 bars 16 millimetres in diameter, is provided at intervals of 5 feet. At these points the thickness of the walls is increased to 57 centimetres; between them steel bars give longitudinal reinforcement. The walls are designed for an internal pressure of 4 kilogrammes per square centimetre (about 60 pounds per square inch). The gallery is trapezoidal in section, 1.85 metres high, 1.40 metres wide at the top, and 1.60 metres wide at the bottom. On the side towards the observation room, half way up the wall, are placed 10 windows, 200 by 150 millimetres, of reinforced glass 30 millimetres thick.

Dust explosions are produced either by firing a charge of some explosive or by the explosion of firedamp. Two mortars are provided for firing explosives, one 600 millimeters long by 55 millimetres bore, capable of withstanding a pressure of 7,500 kilogrammes per square centimetre (about 48 tons per square inch), and the other 1.2 metres long and 40 millimetres bore, capable of withstanding double the pressure of the first. The firedamp used is drawn from one of the Liévin mines at a depth of 526 metres, through a pipe line 1,600 metres long. About 75 cubic metres are received daily. The firedamp is stored in two gasometres, of 300 and 25 cubic metres capacity respectively. Apparatus is provided whereby the gas can be delivered to the experimental gallery in any desired quantity to make up specific mixtures.

Pressures generated by explosions within the gallery are measured by the crushing of a small copper cylinder placed between a resistance block and a piston to which the pressure is communicated. For small pressures, a lead sheet into which a steel ball is pressed replaces the copper cylinder. The pressure measuring devices are placed at one of the observation windows of the gallery, the glass of which is replaced by sheet iron. The speed of propagation of the flame is measured by a chronometer; a Weiss chonograph is to be installed for this purpose later.

The station is equipped with apparatus for testing safety lamps. This consists of a rectangular metallic tube, 310 by 150 millimetres in section, which revolves about a horizontal axis. On the shaft is mounted a mixing device comprising three valves, two of which are pierced with holes; the third is plain. The intermediate valve has a large number of obliquely drilled holes through which air and gas converge towards the interior of the tube. The plain valve moving over this one regulated the delivery. The rear valve has holes corresponding to the air holes in the intermediate valve and regulates the amount of air in the mixture. The whole apparatus is placed outside a special window of the observation room while the valves are operated from the inside.

THE INDUSTRIAL APPLICATIONS OF TANTALUM.

A BRIEF REVIEW OF ITS PROPERTIES AND USES IN THE MECHANICAL AND ELECTRICAL INDUSTRIES.

Alexander Siemens—Royal Institution of Great Britain.

METALLIC tantalum was produced chemically by Berzelius in 1824, and by Moissan in his electric furnace in 1902, but little was known of the properties of the metal until 1904, when von Bolton, in search of a satisfactory substitute for carbon in the filament of incandescent lamps, succeeded in devising a process by which absolutely pure tantalum could be obtained. Moissan describes tantalum as a hard, brittle metal of a specific gravity of 12.8, and a non-conductor of electricity, but he adds that the substance obtained by him contained about 0.5 per cent. of carbon. Von Bolton's product was tough and malleable like steel, and in this pure state, without the admixture of carbon

or other impurities, which, it is reasonable to assume from the differences between the observations of Moissan and von Bolton, exercise a great influence on the physical properties of the metal, tantalum has been found to possess a number of valuable mechanical and electrical properties. These are briefly summarized below, after a recent paper by Alexander Siemens before the Royal Institution of Great Britain, published in *The Electrical Engineer* for July 30.

"In nature, ores containing tantalum are found in many places, principally in Scandinavia, North America, Southwest Africa, and Western Australia. Columbite contains from 10 to 40 per cent. of tantalum pentoxide (Ta_2O_5), and a good deal of niobium combined with iron and manganese in various proportions. As the separation of tantalum and niobium is somewhat troublesome it is preferable to utilise tantalite, which consists almost entirely of iron and manganese combined with tantalum pentoxide. From these ores tantalum is separated in the form of a fluoride in combination with potassium (K_2TaFl_7), and subsequently reduced by metallic potassium to the black powder already mentioned, which, however, still contains some oxide and some hydrogen. In order further to purify the product the powder is pressed into the form of small cylinders, which are melted in a vacuum by an electric current under certain precautions into small buttons of pure tantalum."

Methods of extraction have been improved so that tantalum produced at the present time is much purer even than that exhibited in 1905 by von Bolton and Feuerlein. Experiments have been made recently by Sir James Dewar on pure specimens to determine the specific heat and thermal conductivity of the metal. His values for specific heat are: between 100 degrees C. and 14 degrees C., 0.033; between 14 degrees C. and —78 degrees C., 0.032; between —78 degrees C. and —183 degrees C., 0.028. Von Bolton's value was 0.0363. The results of Sir James Dewar's experiments prove tantalum to have about three-quarters the conductivity of iron and about one-eighth the conductivity of copper.

"At ordinary temperatures, say below 300 degrees C., pure tantalum resists the action of all acids, except fluoric acid, of all alkalies, and of moisture, so that it is an ideal material for chemical apparatus which do not require high temperatures and for any implements which, when made of steel, are liable to rust. It has already been stated that pure tantalum is tough and malleable, so that it can be hammered out into thin sheets or drawn into fine wire, the diameter of the filament wire being 0.03 millimeter, or about 1-800 inch; all the same, it is elastic and as hard as soft steel, and has a tensile strength of 93 kilogrammes per square millimetre, which is equal to 57 tons per square inch. This means that the filament wire is capable of supporting about 80 grammes, or 2.8 ounces. Tantalum sheet can be stamped into various shapes, and out of bars of tantalum springs can be bent.

"Another use made of tantalum is as material for writing pens, manufactured in the usual way. When it was first offered for this purpose, it was found that the material could not pass the test prescribed for pens made of steel. These are pressed by a weight of 180 grammes on writing paper, which is moving at the same speed as ordinary writing, and while 10 kilometres (6¼ miles) of paper are passing, the loss by abrasion must not exceed 0.7 milligramme (0.01 grains). At first the tantalum pens lost more than double the permitted weight, but it was found that slightly oxidising the surface of the pens hardens them so much that they only lose 0.8 milligrammes by the 10-kilometre test. By weight this is still more than permitted for steel pens, but having regard to the specific weights of the two substances, the actual volumetric abrasion of the tantalum pen is the lesser of the two.

"Although only the surface of the pens had been oxidised it was found that the rate of abrasion remained the same for the whole length of 10 kilometres, when it was expected that this rate would increase materially after the skin of ox-

ide had been ground off. Advantage was taken of this circumstance when an inquiry was received from India whether it would be possible to manufacture cataract knives for oculists out of tantalum. The qualities demanded of such a knife are that its blades should be: (1) intensely hard, so as to be able to acquire a very sharp edge of great smoothness, and to retain this fine edge for a long time; (2) very tough without any tendency to bend; (3) chemically and mechanically stable, so that it can be easily sterilised and that it is not liable to rust; (4) capable of acquiring a high polish. Manufacturing such a blade out of pure tantalum and slightly oxidising it before polishing it appears to fulfil these stringent conditions. Another field for the application of tantalum may be found in the supply of dental instruments, owing to its immunity from chemical changes.

"While possessing all these qualities of a true metal, tantalum has some others which rather limit its usefulness. When heated to a dull red it absorbes gases greedily, especially hydrogen and nitrogen, and by combining with them it loses its tensile strength and becomes brittle. On heating tantalum in air, it shows first a yellow and then a blue tint like steel, but when the heating is continued it burns to pentoxide. The black powder and thin wires can even be lighted by applying a match to them. Its melting point, *in vacuo*, lies between 2,250 degrees C. and 2,300 degrees C., which makes it particularly suitable for electrodes in vacuum tubes, especially as it does not disintegrate—for example, Ta electrodes are extensively used in Röntgen tubes—and its specific weight is 16.6.

"Turning now to the electrical qualities of tantalum, its specific resistance was stated by Dr. von Bolton, in 1905, to be on the average 0.165, with a temperature coefficient of 0.3 per cent. between 0 degrees and 100 degrees C. Further experiments conducted by Dr. Pirani in the laboratory of Siemens and Halske revealed the fact that wires of various thicknesses varied in their specific resistance from 0.173 to 0.188; but after they had been heated to 1,900 degrees C. in a high vacuum for from 100 to 200 hours, they all possessed the same specific resistance—viz., 0.146—and their temperature coefficient between 0 degrees and 100 degrees C. had risen to 0.33 per cent. As a temperature of the tantalum filament, when consuming 1.5 watts per candle-power, is about 1,850 degrees C., and its resistance about six times its resistance at 100 degrees C., the temperature coefficient between 100 degrees and 1,850 degrees C. may be taken, on the average, as 0.29 per cent. No doubt the difference between these results is caused by alterations in the structure of the wires during their manufacture, and the heating *in vacuo* served a similar purpose to the annealing of steel, so that Dr. Pirani's results published in 1907 may be taken as standards.

"At present the most important industrial application of tantalum is its use for the filaments of incandescent lamps, which may be said to date from July, 1903, when Dr. Feuerlein had succeeded in producing a tantalum wire 1-20 millimetre in diameter. Of this wire he made a glow lamp with a filament 54 millimetres long, using a current of 9 volts 0.58 amperes, and giving a light of 3.5 candles (Hefner), at the rate of 1.5 watts per candle-power. A simple calculation shows that for a current of 110 volts 660 millimetres of the same wire would be required, giving at the same rate of consumption of energy a light of 43 candles. In carbon lamps for 220 volts the length of filament is only 400 millimetres, and the filaments remain hard until they disintegrate. Tantalum filaments, like other metallic filaments, soften, however, to such a degree that they cannot be used in the same shape as carbon filaments. After trying various methods of housing the long Ta filament in a glass bulb of approximately the same dimensions as the carbon glow lamps, the present form was arrived at during the year 1904. In this lamp, which was adopted as standard, the length of the filament was 650 millimetres, its diameter 0.05 millimetre, and

its weight 0.022 grammes, so that about 45,000 of these lamps contain 1 kilogramme of Ta. Since then these dimensions have been modified to a certain extent; for instance, the diameter of the filament is now only 0.03 millimetre, but the external shape has not been altered. It was soon found that after burning a short time the filament underwent certain structural changes and lost its great tensile strength. Examination under a microscope revealed the fact that in about 1,000 hours the smooth cylindrical filament shows signs of capillary contraction, as if the cylinder was going to break up into a series of drops, and the surface, from being dull, commences to glitter. This contraction of the filament after being heated is readily recognised by comparing a new lamp with an old one. On the stars of the new lamp the filament hangs loosely, while in the old lamp the filament is evidently in tension.

"The characteristic difference between carbon filaments and tantalum filaments is that the resistance of a Ta alters directly and that of carbon inversely as the temperature. Owing to this quality, a tantalum filament is better able to resist overheating than a carbon filament.

"In conclusion, two interesting qualities of Ta should be noted. The first is that when a Ta filament is heated in a high vacuum it will expel any oxygen that has combined with it. It is possible to detect whether a filament contains any oxide by very gradually heating it up, when the parts containing oxide will appear brighter than those consisting of pure Ta, owing to the greater electrical resistance of the oxide. The second is that Ta will act as a rectifier when used in an electrolyte—that is to say, it will allow of the passage of the positive current only in one direction; in a very short time the Ta anode covers itself with a film of oxide which stops the current. When the remarkable qualities of this material are fully appreciated and its limitations are properly understood, there appears to be a great field open to tantalum and its industrial applications."

THE ECONOMICS OF MOTOR OMNIBUSES.

A DISCUSSION OF THE EXPENSES, PROFITS AND POSSIBILITIES OF MOTOR OMNIBUS LINES IN EUROPEAN CITIES.

K. Otto—Bulletin of the International Railway Congress

A REPORT on the advantages, disadvantages, and results of working of motor omnibuses in Europe, prepared by K. Otto from information supplied by the managements of a large number of omnibus companies and presented to the International Tramways and Light Railways Union at the Munich meeting in 1908, is published in the July number of the *Bulletin of the International Railway Congress*. It presents very clearly the economics of this type of transport and, as will be seen from the following abstract, shows abundant reasons why the motor omnibus cannot yet hope to compete with the electric railway.

Nearly all motor omnibuses at the present time are still driven by internal-combustion motors, in which petrol is generally used. The information received clearly shows that during the year the construction of motor omnibuses, particularly as regards the transmission of the energy of the motor to the driving axle, was not modified to any material extent. The rivalry between live axles and chains still continues, and it was impossible to give definite preference to either system. There has been, however, distinct progress in the adoption of a casing protecting against the dust certain parts of the motor which formerly were generally exposed.

It is a remarkable fact that for fuel petrol having a specific gravity of about 0.7 is almost exclusively used. Most managements seem to be afraid to try benzol, which works just as well and is much cheaper. Benzol has been tried on a

large scale by the Berlin Tramways Company, with such satisfactory results that the use of petrol has been entirely discontinued. The price of petrol has fallen only from 17s. 8.3d. to 14s. 6.2d. per 100 pounds; commercial benzol, from which water and all bad smelling impurities have been removed, costs only 8s. 7.4d. per hundred pounds. If stored in underground tanks, benzol is not liable to freeze, and no trouble has been experienced in using it during the winter months. The alterations in the carburettors, or rather in the air-admission gear, necessary when changing from petrol to benzol are so slight that they can easily be made in one day. The consumption is about the same for the two fuels; it varies with the weight of the car, the speed, and the profile of the line between 0.99 and 1.77 pounds per car mile.

A still greater saving can be effected by taking advantage of the present favorable condition of the rubber market. Prices have fallen to their normal level, and the cost of a set of solid rubber tires is given as varying between £70 and £127. For a motor omnibus weighing about 5 tons, £70 to £75 per set can be considered quite normal. As regards guarantees, the manufacturers have returned to the reasonable figure of 9,300 miles, so that under normal conditions the cost of rubber tires will be 1.93d. per car mile.

The cost of maintenance of motor omnibuses varies considerably with the work they have to do and with the greater or less development given to repairing workshops. Costs of from 0.97d. to 3.17d. per car mile are reported. The lower figure, of course, results only under the most favorable conditions, for instance, when the manufacturers of the cars themselves operate the service and the works where the cars are built are open to the operators. As a general rule the cost of maintenance varies between 1.93d. and 2.32d. per car mile. The consumption of lubricants reported varies between 0.19d. and 0.73d. per car mile, with 0.39d. as an average.

Motor omnibus undertakings may be divided into three groups; services which are essentially urban; suburban lines operated during the whole year and working to a regular timetable; and suburban or excursion lines operated during certain seasons only and working either to a regular timetable or having an optional service. The type of car body varies according to the class of service. On town lines the omnibuses are usually double decked, and the bodies have to be very strongly constructed. Suburban lines generally have single-deck cars only. For excursion traffic still lighter cars are preferred, which in their build approximate more to ordinary motor cars. The weight of omnibuses of these different types varies between 4,000 and 12,100 pounds, according to the number of passengers to be accommodated.

The class of service also exercises a great influence on the cost for labor. On town lines conductors are necessary and generally cost as much as for tramways, say about 1.93d. per car mile. In the majority of cases omnibus conductors are required to be more able than tramway conductors and are more highly paid; 2.12d. may be taken as an average cost per car mile. The two other kinds of service may be able to do without conductors and so reduce their wages bill; on the other hand their staff can often not be utilized to full advantage, so that part of the saving so effected is lost. For general expenses, that is, cost of management and insurance, it is correct to allow at least the same amount as in the case of tramways, 0.39d. to 0.58d. per car mile.

The working expenses of a town service of some importance are as follows, in pence, per car mile:

General management	0.39
Car staff	2.12
Supervision	0.19
Fuel (benzol, 1.419 pounds at 1.089d. per pound)	1.54
Lubrication and lighting of cars	0.58
Renewal of tires	1.93
Maintenance of cars and garage expenses	2.51
Insurance and miscellaneous	0.58
Total	9.84

This figure of 9.84d. represents the extreme limit of economy which can be

attained if the rolling stock is well kept and carefully maintained. When petrol is used instead of benzol, or where more has to be paid for tires, the working expenses may easily rise to 11.55d. or 1s. 0.55d. per car mile. It has been shown that, even in the case of small tramway undertakings providing rural services, the cost per car mile, including all the financial charges for a reserve fund and for amortization, including 4 per cent. for interest on capital, varies between 4.63d. and 7.72d. The working expenses of a tramway service, financial charges included, are thus much lower than the net working expenses of a motor-omnibus service; and this fact alone condemns the existence of such a system of transport, at all events for town and suburban traffic.

In Germany at least, there is on record no essentially urban tramway system, and only very few suburban systems, on which the receipts amount to 9.84d. per car mile. On the other hand, there is no reason why urban and suburban motor-omnibus services should hope to obtain considerably higher receipts per car mile than tramways, the more so as the possible advantage of the very slightly greater speed of the motor omnibuses is largely counterbalanced by the numerous disadvantages which these vehicles offer to the public. Another advantage, moreover, in favor of tramways, is that when the traffic grows and cars are run at shorter intervals, the expenses per car mile become materially reduced, whereas in motor-omnibus working they remain practically the same. In Berlin there is only one line where the receipts not only cover the working expenses but leave a satisfactory surplus. This line has a particularly favorable route and forms a sort of supplement to the tramway service. In competition with tramways it is hardly probable that motor omnibuses can pay expenses, much less make a profit. Nor is the assumption warranted that they will be successful in small towns. One can hardly expect to see motor omnibus lines introduced inside towns and their suburbs except when communal or private interests justify the working loss which must with certainty be expected, or when such deficit is more than counterbalanced by other advantages, such as the opening up of new districts, resultant rise in the price of land, etc.

Experience has shown that in order to keep about 45 cars on the road, a reserve of about 30 per cent. is necessary, so that altogether about 60 cars are required. The installation of underground tanks for the storage of petrol or benzol costs about £50 per car. The capital cost of a garage to hold a large number of cars will amount to about £300 per car. The total capital cost of a line of 60 motor omnibuses will be, therefore, for 60 cars at £950 per car (without tires), £57,000; for tires and working capital, £6,000; and for garage with petrol tanks and workshop, £18,000; a total of £81,000.

With regular maintenance, the life of a motor omnibus may be estimated at 186,400 miles. As each car costs £950, and as its scrap value may be taken at £50, the amortization should be at the rate of 1.16d. per car mile. In the case of a regular service, a motor omnibus will run about 27,960 miles in 300 days of work. The total performance will thus be, in round figures, 1,243,000 car miles. The financial charges, then, counting interest at 4 per cent., amortization of buildings at 2 per cent., and amortization of tanks and workshops at 12 per cent., amount to 1.92d. per car mile. When the operating costs are added, the total expense per car mile becomes 11.77d. As low a figure as this can only be attained by profiting by every possible advantage.

In conclusion, the rational operation of a motor omnibus service is only possible in very special cases, in which neither competing lines nor the ordinary tariffs have to be taken into consideration. The use of the motor omnibus elsewhere will be limited to cases in which the deficits will be justified by special conditions. We are therefore for the time being still very far from seeing motor omnibuses replace electric street railways.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING.

BRIDGES.

Arches.

Computation of Stresses in Open-Webbed Arches Without Hinges. C. W. Hudson. Gives a method for finding the stresses in every member of the arch due to a load at any point, or for any desired change in temperature. 1800 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7363 E.

Concrete.

The Construction of the Edmondson Avenue Bridge, Baltimore. Illustrated detailed description of methods used in constructing a bridge with three arch spans of 60 ft. and one of 139 ft. 3500 w. Eng Rec—Aug. 14, 1909. No. 7071.

A 259-Ft. Concrete Arch Bridge in Switzerland. Illustrated description of details of design and erection of the Sitter arch bridge. 2500 w. Eng News—Aug. 5, 1909. No. 6906.

Design.

Stray Thoughts on Bridge Design and Maintenance. Herbert C. Keith. Read before the Conn. Soc. of Civ. Engrs. Calls attention to details that affect the life and strength of materials. 4000 w. Engng-Con—Aug 4, 1909. No. 6901.

Erection.

Derrick Cars and Bridge Erection. J. H. Prior. A fully illustrated article describing the designs and features of such

We supply copies of these articles. See page 156.

cars, their operation and uses. Also gives tests of iron pulley blocks, and general discussion. 10000 w. Jour W Soc of Engrs—Aug., 1909. No. 7422 D.

Erection Travelers.

Dismantling a Traveler. J. C. Worrell. Describes the unique manner in which a traveler at Clinton, Iowa, was dismantled. Ills. 700 w. Eng Rec—Aug. 7, 1909. No. 6949.

Foot Bridges.

Street Crossing Foot Bridge at a Ferry Terminal, New York. Details and brief description of a covered steel structure furnishing entrance and exit for the ferry house of the C. R. of N. J. 900 w. Eng Rec—Aug. 14, 1909. No. 7074.

Manhattan.

Progress on the Manhattan Bridge. Describes recent work on the cables, the machines used, special falsework, floor system, etc. Ills. 3000 w. Eng Rec—July 31, 1909. No. 6793.

New York City.

The Bridges of New York City. T. Kennard Thomson. An illustrated discussion of their design, construction, and chief traffic relations. Serial, 1st part. 3000 w. Engineering Magazine—Sept., 1909. No. 7416 B.

Reinforced Concrete.

Walnut Lane Bridge, Philadelphia. George S. Webster and Henry H. Quimby. Illustrated description of this bridge, notable for the great size of its main arch, discussing the principles of its design, the reasons for its special features, and the lessons learned in course of its construction. 13500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7364 E.

Method and Cost of Constructing a Reinforced Concrete Arch Street Bridge at Baltimore, Md. Relates to the construction of the Stony Run Bridge. 1700 w. Engng-Con—Aug. 4, 1909. No. 6898.

Steel.

Erection of Additional Girders—Williamsburg Bridge Towers. Illustrated description of method of strengthening this bridge for increased capacity. 1800 w. Eng Rec—Aug. 21, 1909. No. 7302.

The Long Span Riveted Truss French River Bridge. Illustrated detailed description. The most interesting feature is the special construction of the main end bearings. 1500 w. Eng Rec—Aug. 28, 1909. No. 7387.

Railway Bridge Over Shiré River, Nyasaland. Illustrated description of a lifting bridge of rather novel design. 500 w. Engng—July 23, 1909. No. 6855 A.

The Gualeguay River Bridge. J. R. Garrod and P. J. Risden. Explains the unusual conditions, and gives illustrated description of the design and construction. Plate. 2500 w. Engng—July 23, 1909. No. 6848 A.

Accurate Design of Parallel Girders with a Double System of Diagonals and Posts (Genauere Berechnung von Parallelträgern mit einem doppelten System von Zugdiagonalen und Ständern). Friedrich Hartmann. Describes method. Mathematical. Ills. 5700 w. Zeitschr d Oest Ing u Arch Ver—July 17, 1909. No. 7457 D.

See also Arches, and Foot Bridges, under BRIDGES.

Swing Bridges.

An English Double-Deck Swing Bridge for Railway and Roadway Traffic. Drawings and detailed description of the double-track swing bridge with unequal arms, crossing the river Avon at Bristol, England. 4500 w. Eng News—Aug. 19, 1909. No. 7138.

CONSTRUCTION.

Beams.

Lateral Strength of Beams. H. D. Hess. A discussion applicable only to present standard structural shapes. 900 w. Pro Engrs' Club of Phila—April, 1909. No. 7114 D.

Rigidly Connected Continuous Beams (Poutres à Travées Solidaires). M. Levaillant. Mathematical demonstration of a rapid method of obtaining bending-moment and shearing-stress curves. Ills. 5500 w. Ann d Ponts et Chaussées—1909-III. No. 7123 E + F.

Brick.

A High Record in Bricklaying Attained by Novel Methods. L. W. Peck. Illustrated description of methods giving a large output per man and low cost per thousand, in construction work at Chelsea, Mass. 2500 w. Eng News—Aug. 5, 1909. No. 6911.

Reinforcement for Ordinary Walls (Impiego della Lamiera stirata per Armare la Muratura ordinaria). A. Anastasi. Describes a type of reinforcement applicable to brick and masonry walls, for use in earthquake countries. Ills. 1000 w. Ann d Soc d Ing e d Arch Ital—July 1, 1909. No. 7238 F.

The Edison Concrete House. Illustrates and describes this invention for providing comfortable and sanitary homes for workingmen at moderate cost. 1200 w. Sci Am—Aug. 28, 1909. No. 7379.

Experiments to Determine Pressure of Concrete on Forms. Francis R. Spunk. Abstract from *"Prof. Mem."* Engrs' Bureau, U. S. A. An account of experiments made at Lock No. 1, on the Mississippi River between St. Paul and Minneapolis, to determine the pressure of concrete on forms at various temperatures and rates of filling. Ills. 1400 w. Engng-Con—Aug. 25, 1909. No. 7342.

See also Retaining Walls, under CONSTRUCTION.

Contractors' Plants.

Construction Plant Employed on the New York Water Supply. H. Prime Kieffer. Illustrates and describes the exten-

sive and costly plant installed to secure the highest quality and greatest possible rapidity of the work. 1500 w. Munic Engng—Aug., 1909. No. 7028 C.

Earthquake.

Construction in Earthquake Countries. William Herbert Hobbs. Considers the actions of shocks and types of quake-proof structures, the materials, designs and related matters. Ills. 6500 w. Engineering Magazine—Sept., 1909. No. 7417 B.

Construction in Countries Subject to Earthquake Shocks (La Construction dans les Pays sujets aux Tremblements de Terre). E. Lemaire. The report of the Italian commission appointed to consider the best type of construction is reviewed. Ills. 4800 w. Génie Civil—July 17, 1909. No. 7232 D.

Building Regulations for the Italian Earthquake Regions (Norme Edilizie per le Regioni Italiane Colpite da Terremoti del 28 Decembre 1908 od Anteriori). Editorial discussion of the report of the commission appointed to study this problem. 6000 w. Il Cemento—July 15, 1909. No. 7243 D.

Report of the Sub-Commission Appointed to Visit the Earthquake District in Calabria and Sicily (Relazione della Sottocommissione Incaricata di Visitare le Località Colpite dal Terremoto Calabro-Siculo del 1908). Text of the report presented to the Italian Government. Ills. 3500 w. Ing Ferro—July 1, 1909. No. 7245 D.

Earthwork.

Notes on Shrinkage of Earthwork and on Steam Shovel Work. F. Pardoe Wilson. Part of a paper before the Can. Soc. of Civ. Engrs. Discusses methods of applying shrinkage in embankment work. 600 w. Eng News—Aug. 12, 1909. No. 7053.

Excavation.

Machinery for Canal and Ditch Excavation. Editorial on recent developments in this class of machinery and the possibilities. 2500 w. Eng News—Aug. 26, 1909. No. 7359.

Fences.

See Retaining Walls, under CONSTRUCTION.

Fireproof.

Milford Paper Mills, Warren Manufacturing Company. Illustrated description of methods of construction used for a fireproof mill in New Jersey. 1500 w. Eng Rec—July 31, 1909. No. 6795.

The New School Buildings of Cincinnati. W. P. Anderson. Describes in detail the efforts to make fireproof the recent public school buildings, and the new features introduced. 1000 w. Eng Rec—Aug. 7, 1909. No. 6951.

Practical Fire Test of a Reinforced Concrete Factory. Illustrates and describes the condition of a factory in Philadelphia after passing through an intensely hot fire. 800 w. Cement Age—Aug., 1909. No. 7122.

Foundations.

Application of Reinforced Concrete Piling in Foundations, Station "C," Oakland, Cal., of the Pacific Gas and Electric Company. H. C. Vensano, in *Pacific Gas and Electric Mag.* Illustrated description of foundation work using concrete piles with concrete caps. 2200 w. Am Gas Lgt Jour—Aug. 9, 1909. No. 6932.

Substructure of the New Meier & Frank Building. Gives details of a ten-story steel frame building, not including a basement, under construction in Portland, Ore., describing especially the waterproofing, underpinning, and other work of interest. Ills. 1800 w. Eng Rec—Aug. 7, 1909. No. 6947.

Gas Holders.

A Large Reinforced-Concrete Gas Holder (Grande Vasca Gasometrica in Cemento Armato). Illustrated description. 2000 w. Il Cemento—July 31, 1909. No. 7244 D.

Grain Elevators.

A Large Reinforced-Concrete Grain Warehouse in Duluth. Illustrates and describes a warehouse of the circular-bin type being built for the Great Northern Ry. Co., at Superior, Wis. 2500 w. Eng Rec—Aug. 28, 1909. No. 7384.

Reinforced Concrete.

Reinforced-Concrete Buildings for a Large Manufacturing Plant. W. A. Hoyt. Illustrates and describes the new plant of the Corn Products Co., at Argo, Ill., near Chicago. 4000 w. Eng News—Aug. 26, 1909. No. 7356.

The New Shanghai Telephone Exchange Building. C. Luthy. Illustrated description of an elaborate reinforced-concrete, six-story building recently completed. 1200 w. Eng Rec—Aug. 21, 1909. No. 7300.

Calculation and Design of Rectangular Slabs Supported on All Four Sides (Beitrag zur Berechnung und Dimensionierung vierseitig aufgelagerter Platten). C. Abeles. Mathematical. Ills. Serial, 1st part. 2000 w. Deutsche Bau—July 17, 1909. No. 7280 B.

See also Gas Holders, Grain Elevators, and Steel, under CONSTRUCTION; Caissons, under WATERWAYS AND HARBORS; Shafts, and Shaft Sinking, under MINING AND METALLURGY, MINING; and Ties, under STREET AND ELECTRIC RAILWAYS.

Retaining Walls.

A Concrete Fence and Retaining Wall. Warren H. Miller. Describes method of construction, giving itemized costs. Ills. Eng Rec—Aug. 21, 1909. No. 7309.

Stacks.

Simple Method of Stack Design. A. J. Haire, Jr. Gives diagrams and explanation of their use. 900 w. Mach, N Y—Aug., 1909. No. 6808 C.

We supply copies of these articles. See page 156.

Steel.

The Racquet Club House, Philadelphia. Illustrates and describes a building having unusual features to meet special requirements. 1500 w. Eng Rec—Aug. 21, 1909. No. 7306.

The Engineering Features of the Athletics' Baseball Park. Michael Monaghan. Illustrates and describes structural-steel work, reinforced-concrete work, etc., of a building in Philadelphia. 2500 w. Pro Engrs' Club of Phila—April, 1909. No. 7113 D.

Elastic Limit or Yield-Point as Guide for Working-Stresses. Editorial discussion giving reasons for attaching chief importance to the "yield-point." 1200 w. Eng News—Aug. 5, 1909. No. 6910.

The Influence of Rigid Rivetting at Junction Points on the Deflection of Beams (Der Einfluss der festen Knotenpunktvernietung auf die Durchbiegung von Fachwerkträgern). Paul Müller. Mathematical and graphical discussion. Ills. 2800 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7467 D.

Tunnels.

The Gunnison Tunnel of the Uncompahgre Valley Project, United States Reclamation Service. I. W. McConnell. Map and illustrated description of the construction of the longest irrigation tunnel in the world. 7000 w. Eng Rec—Aug. 28, 1909. No. 7382.

Progress of the Southwest Water Tunnel in Chicago. Illustrated detailed description of methods used in constructing this water supply tunnel. 4000 w. Eng Rec—Aug. 7, 1909. No. 6946.

MATERIALS OF CONSTRUCTION.

Cement.

See Mortar, under MATERIALS OF CONSTRUCTION.

Mortar.

The Chemical and Microscopic Study of Mortar, Cement, and Pozzuolana. Summary of effects observed by different examiners. 1500 w. Builder—Aug. 7, 1909. No. 7082 A.

Trass, Trass-Cement, and Cement-Lime Mortars (Einiges über Trass-, Trasszement- und Zementkalkmörtel). Heinrich Renezeder. Results of investigations of their properties. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—July 10, 1909. No. 7455 D.

Reinforced Concrete.

Reinforced Concrete. Arthur C. Auden. Remarks on its lasting qualities, the materials used, and their comparative value, reinforcement, the uses to which this material is applied, etc. Ills. 8000 w. Inst of Mech Engrs—July, 1909. No. 6983 N.

Steel.

The Slipping Resistance of Nickel Steel Rivets (Die Festigkeit von Nickelstahlnieten unter besonderer Berücksichtigung des Gleitwiderstandes). E. Preuss. Results of experiments. Ills. 2700 w. Stahl u Eisen—July 28, 1909. No. 7265 D.

Steel Sections.

Test of Standard and Wide-Flange I-Beams. Edgar Marburg. Abstract of paper before the Am. Soc. for Test. Mat., with editorial note. Reports results of tests to determine the strength and behavior, and a comparison between standard and wide-flange beams. Ills. 3800 w. Eng News—Aug. 12, 1909. No. 7051.

Stone Preservatives.

Means of Preserving Natural Stone against Disintegration (Ueber Konservierungsmittel zum Schutze der aus natürlichem Gestein aufgeführten Bau- und Bildwerke gegen Verwitterung). Max Setz. Describes briefly various methods. 2800 w. Oest Wochenschr f d Oeffent Baudienst—July 3, 1909. No. 7454 D.

Stucco.

Mortars for Stucco and Methods of Applying and Finishing Stucco. Gives precautions that should be observed to secure good work. 2500 w. Engng-Con—Aug. 11, 1909. No. 7003.

Timber.

Standard Specifications for Grading Structural Timber. Data from a report of a committee to the Am. Soc. of Test. Mat. 2500 w. Eng Rec—Aug. 7, 1909. No. 6948.

Timber Preservation.

A Timber Treating Plant at Madison, Illinois. Illustrated description of a timber-creosoting plant and the methods used. 3500 w. Eng Rec—Aug. 7, 1909. No. 6953.

The Preservation of Mine Timbers. John M. Nelson. Abstract of paper read before the Coal Min. Inst. of America. Brief remarks on the best methods of prolonging the life of timbers. Ills. 1600 w. Eng & Min Jour—July 31, 1909. No. 6791.

Trass.

See Mortar, under MATERIALS OF CONSTRUCTION.

MEASUREMENT.

Current Meters.

The Use and Care of the Current Meter, as Practiced by the United States Geological Survey. John C. Hoyt. Illustrated description of the instruments and their use. 10000 w. Pro Am Soc of Civ Engrs—Aug., 1909 No. 7362 E.

Stream Gauging.

Ratings of a Pitot Tube. E. C. Murphy. Discusses the rating of the tube used in the U. S. Geol. Survey debris investigation laboratory for the measurement of small, shallow, open streams. Ills. 800 w. Eng News—Aug. 12, 1909. No. 7054.

See also Current Meters, under CIVIL ENGINEERING, MEASUREMENT.

Surveying.

Some Extensive Railroad Surveys, and Their Cost per Mile. Discussion of the

paper by W. S. McFetridge, on this subject. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7368 E.

Testing Methods.

Notes Regarding the Testing of Materials. W. G. Kirkaldy. Read before the Inst. of Co. and Munic. Engrs. Remarks on the principles involved in such tests and the more useful ones to apply to certain materials. 3500 w. Surveyor—July 30, 1909. No. 6968 A.

New Tests for Building Construction. Guy Elliott Mitchell. Discusses the investigations of the United States government on the subject of structural materials, their economic importance, the testing machines, and materials tested. Ills. 4000 w. Am Rev of Revs—Aug., 1909. No. 7020 C.

MUNICIPAL.

Drainage.

Method of Taking Care of Surface Run-off at the Villagrazia Magazine, Palermo (Sistemazione delle Acque piovane nella Polveriera di Villagrazia, Palermo, e Studio di un Pozzo assorbente). Alessandro Migliozzi. Describes the problem and its solution by a drainage system. Mathematical. Ills. 3300 w. Monit Tech—July 30, 1909. No. 7239 D.

Pavements.

A Review of Chicago Paving Practice. P. E. Green. A review of types of street pavement laid, the methods of construction, wearing qualities, etc. Ills. 12500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7365 E.

Refuse Destructors.

Devices for Charging Refuse into High Temperature Refuse Incinerators. Samuel A. Greeley. An illustrated article showing the respective features of hand-charged and mechanically-charged incinerators of the high-temperature type. Compares their cleanliness, construction, operation, efficiency and cost. 8000 w. Eng News—Aug. 26, 1909. No. 7357.

Roads.

Road Materials and Some Simple Rules for Testing Them. Austin B. Fletcher. Read before the Congress of Road Bldrs. Discusses principally materials used in Massachusetts, such as sand and clay, gravel, rock, and bituminous materials. 3500 w. Eng Rec—July 31, 1909. No. 6794.

The Cost of Constructing Macadam and Gravel Roads in Missouri, with Data on the Amount of Materials Required. From bulletin issued by the Missouri Highway Dept. 2000 w. Engng-Con—Aug 4, 1909. No. 6900.

Italian Highways (Le Strade ordinarie in Italia). A detailed description of the systems of road administration, construction and maintenance in the various provinces. Serial, 1st part. 4700 w. Monit Tech—July 30, 1909. No. 7240 D.

Sewage Disposal.

Sewage Disposal. Discusses methods calculated to remove putrescibility. 2000 w. Can Engr—Aug. 6, 1909. Serial, 1st part. No. 6936.

Status of Sewage Disposal in America. Alexander Potter. From an address at Indianapolis, Ind. On the need of concerted action and advising the creation of a National Board of Health to advise and arbitrate where interstate questions arise. Ills. 1500 w. Munic Engng—Aug., 1909. No. 7029 C.

The Disinfection of Sewage and Sewage Filter Effluents. Earle Bernard Phelps. Condensed from Paper 229, U. S. Geol. Survey. Considers the purifying agents, the necessity of disinfection, methods, tests made, and conclusions. 5800 w. Engng-Con—Aug. 11, 1909. No. 7005.

An Aerating and Flushing System for Percolating Sewage Filters. William Gavin Taylor. Illustrates and describes types of floor systems, especially the false floor system installed at Waterbury, Conn. 3000 w. Eng News—Aug. 19, 1909. No. 7141.

Sewage Contact Filters with Automatic Control at Auburn. Illustrated detailed description of a recently completed plant at Auburn, N. Y. 2000 w. Eng Rec—Aug. 21, 1909. No. 7305.

Sewerage and Sewage Disposal Works at Ruislip-Northwood. W. Louis Carr. Sketches the conditions and general character of the district, showing the difficulties, methods of overcoming them, and the results. 5000 w. Surveyor—July 30, 1909. No. 6969 A.

The Sewer System of San Francisco, and a Solution of the Storm-Water Flow Problem. The paper by C. E. Grunsky is discussed. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7370 E.

The Principal Claims of Collecting Sewers (Ueber Sammelkanäle und deren Höchstbeanspruchung). Wilhelm Voit. A discussion of their design, with description of types, etc. Ills. Serial, 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—July 9, 1909. No. 7452 D.

Sewer Gases.

Bacteria in Sewer Air. C. E. A. Winslow. An examination of the possibilities of disease infection being carried by means of sewer air, with conclusions. 3000 w. Can Engr—Aug. 20, 1909. No. 7181.

Sewers.

A Study Into the Comparative Advantages of Day Labor and Contract Sewer Construction. 3500 w. Engng-Con—Aug. 25, 1909. No. 7343.

Sewer Tunneling in London. Notes from a paper by Alfred E. Snape, read before the Inc. Assn. of Munic. & Co., Engrs., describing methods employed. Ills. 3500 w. Eng Rec—Aug. 14, 1909. No. 7076.

We supply copies of these articles. See page 156.

Sewers and Sewage Pumping at Grand Rapids, Mich. Explains conditions and illustrates and describes the sewage disposal and pumping plants. 1500 w. Munic Jour & Engr—Aug. 11, 1909. No. 6998.

Stone Crushing.

Cost of Operating a Stone Crushing Plant by City Employees for Three and One-Half Months, Boston, Mass. Data from the report of the Finance Commission, describing the method of operation and giving results. 3500 w. Engng-Con—Aug. 11, 1909. No. 7004.

Street Sprinkling.

Electric Car Street Sprinkler at The Hague (De electrische motorsproeiwagen der Openbare Reiniging te's-Gravenhage). G. H. E. Bergsma. Illustrated description. 2000 w. Ingenieur—July 10, 1909. No. 7481 D.

WATER SUPPLY.

Conduits.

The Design of an Eight-Mile High-Head Hydraulic Conduit. Lars Jorgensen. Remarks on the choice of type, with description of a closed conduit consisting of a buried concrete floor-pipe and rock-tunnel pressure pipe. 2500 w. Eng News—Aug. 5, 1909. No. 6909.

Conservation.

Water Supply Conservation in Mountainous Districts (Ueber Wasserwirtschaft im Gebirge). Max Singer. A discussion referring particularly to conditions in Austria. Ills. Serial, 1st part. 2800 w. Zeitschr d Oest Ing u Arch Ver—July 2, 1909. No. 7451 D.

Dams.

Earthen Dams. Frank Reed. Gives specification and practical profile based on actual practice. 1500 w. Aust Min Stand—June 23, 1909. No. 6865 B.

The Government Dam Across the Rock River at Sterling, Ill. Fred. W. Honens. Illustrated description of conditions and construction of this dam. The overflow portion is a rock-filled crib dam; the remainder consists of a series of vertically revolving gates in sluiceways. 6500 w. Eng News—Aug. 5, 1909. No. 6907.

Accident to Necaxa Dam No. 2. Describes this accident in Mexico, showing the causes that contributed and the steps proposed for the reconstruction and restoration. Ills. 2000 w. Engr, Lond—July 30, 1909. Serial, 1st part. No. 6988 A.

Distribution.

A Problem in the Economic Design of Water Distribution Systems. Rudolph Hering. A statement of the reasons why the central-main system is superior to the ring system. 1200 w. Eng News—Aug. 12, 1909. No. 7052.

Ditches.

See Excavation, under CIVIL ENGINEERING, CONSTRUCTION.

Filtration.

Mechanical Filters. Replies to inquiries relative to mechanical filtration as applied to water supplies. Ills. 1800 w. Can Engr—Aug. 27, 1909. No. 7407.

Preliminary Chemical Treatment as an Aid to Slow Sand Filtration; Indianapolis Water Co. H. E. Jordan. Slightly condensed paper before the Am. Chem. Soc. Explains the peculiarities of White River, from which the supply is taken, and describes the pre-treatment introduced during the period of high turbidity. Ills. 3500 w. Eng News—Aug. 5, 1909. No. 6908.

Sanitary Control of Filter Plants. Francis D. West. Deals with the operation of filter plants controlled by laboratory tests of the water delivered to consumers. Especially considers Philadelphia. 3000 w. Pro Engrs' Club of Phila—April, 1909. No. 7116 D.

Operating Results and Costs, Torresdale Filtration Plant. Explains the methods of operation at this Philadelphia plant, the results obtained, and cost. 2500 w. Eng Rec—July 31, 1909. No. 6796.

Fire Protection.

Fire Protection, Western Electric Works, Hawthorne. Illustrates and describes a very complete system installed near Chicago. 2500 w. Eng Rec—Aug. 14, 1909. No. 7075.

Ground Waters.

A Note on Volger's Theory of the Formation of Ground Waters (Ein Beitrag zur Volgerschen Theorie der Grundwasserbildung). Herr Krüger. A criticism based on laboratory and field investigations. 4400 w. Gesundheits-Ing—July 10, 1909. No. 7293 D.

Hastings, England.

The Water Supply of Hastings. P. H. Palmer. Reviews the history of the supply for this English town. 3500 w. Surveyor—July 23, 1909. No. 6845 A.

High Pressure.

High Pressure System for Chicago. Synopsis of report submitted by city engineer Ericson, giving data concerning high pressure systems in other cities, methods of pumping and costs. Ills. 4000 w. Munic Jour & Engr—Aug. 4, 1909. No. 6876.

Irrigation.

Watering the Uncompahgre Valley. Arthur Chapman. Illustrated account of this nearly completed irrigation project, whicch will reclaim more than 150,000 acres of land. 2500 w. Am Rev of Revs—Aug., 1909. No. 7019 C.

Work on the Roosevelt Irrigation Project in Arizona. D. A. Willey. Illustrates and describes applications of electric power to this work. 1500 w. Elec Rev, N Y—Aug. 14, 1909. No. 7067.

Irrigation in Victoria. Elwood Mead. An explanation of the conditions which

caused financial loss in the earlier development, with hopeful outlook for the future. 1700 w. Eng Rec—Aug. 14, 1909. No. 7072.

Irrigation with Electric Pumps (Riego con Bombas eléctricas). Emilio Guarini. A description of the practice in the Department of Arequipa, Peru. 6400 w. Anales d I Soc Cien Argentina—March, 1909. No. 7253 E + F.

See also Tunnels, under CONSTRUCTION.

Meters.

See Condenser Meters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pipe Corrosion.

Electrolysis of Winnipeg Water Mains. Louis A. Herdt. A report of the electrolysis investigation and survey with recommendations. Ills. 3000 w. Can Engr—Aug. 20, 1909. No. 7180.

The Comparative Values of Various Coatings and Coverings for the Prevention of Soil and Electrolytic Corrosion of Iron Pipe. Robert B. Harper. Read before the Ill. Gas Assn. Gives data bearing on this subject, with description of the theories involved and tests made. 2500 w. Am Gas Lgt Jour—Aug. 9, 1909. Serial, 1st part. No. 6930.

Pipes.

Strength and Deflection of Nearly Circular Pipes under External Pressure (Festigkeit und Durchbiegung von Röhren gegen äussern Flüssigkeitsdruck mit geringer Abweichung von der runden Form). M. Westphal. Mathematical. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7477 D.

Pollution.

The Pollution of Streams. Gives the report submitted at the recent Washington Conference of State and Provincial Boards of Health. 5000 w. Eng Rec—Aug. 7, 1909. No. 6952.

Water and Sewerage Works in a Large Watershed. Abstract of a paper by Alexander Porter, read at meeting at Warren, Ohio, to discuss the improvement of the Mahoning River. 2200 w. Eng Rec—Aug. 28, 1909. No. 7383.

Purification.

The Purification of the Water Supply of Steelton, Pennsylvania. James H. Fuertes. Describes the conditions affecting the design of this plant, its construction, and gives results obtained in operation. Ills. 24500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7366 E.

Water Works.

Water Works of Gary, Ind. Illustrated description of the works of the Gary Heat, Light and Water Co. 1800 w. Munic Jour & Engr—Aug. 18, 1909. No. 7129.

Weirs.

See Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Well Drillers.

Electric-Driven Well-Driller. J. Vale Downie. Illustrated description of the Keystone electric-driven machine. 1000 w. Min & Sci Pr—Aug. 21, 1909. No. 7375.

WATERWAYS AND HARBORS.

Caissons.

Concrete-Steel Caissons: Their Development and Use for Breakwaters, Piers and Revetments. W. V. Judson. Illustrated description of harbor work at Milwaukee, Wis., with reports of tests and description of Algoma caisson work. Discussion. 16800 w. Jour W Soc of Engrs—Aug., 1909. No. 7424 D.

Methods Employed in Computing Reinforced Concrete Caissons for Algoma Breakwater. Gives methods of computing the caisson wells and bottoms, and some tests on beams. 1500 w. Engng-Con—Aug. 18, 1909. No. 7134.

Canals.

The North Shore Channel of the Sanitary District of Chicago. Methods and Cost of Constructing Section One. 2000 w. Engng-Con—Aug. 4, 1909. No. 6899.

The Project for a Main-Danube Ship Canal (Der Stand der Planung für die Main-Donau Grosschiffahrtsstrasse). Herr Gebhardt. A discussion of the present state of the plans. Ills. Serial, 1st part. 1400 w. Deutsche Bau—July 7, 1909. No. 7278. B.

The Gent-Terneuzen Canal (Het kanaal van Gent naar Terneuzen). Ar R. van Loon and N. C. Lambrechtsen. Illustrated description of this waterway in Holland. 6000 w. Ingenieur—July 24, 1909. No. 7482 D.

See also Excavation, under CONSTRUCTION.

Diving Bells.

A New Application of the Diving Bell. Illustrated description of a diving-bell or portable caisson constructed for the German Navy Department for use in deepening the harbor at Tsingtau. 500 w. Sci Am—Aug. 21, 1909. No. 7148.

Dredging.

Memoranda on Dredging in Ambrose Channel, New York Harbor. H. L. Wigmore. From a paper in *Prof. Mem.*, Engr's Bureau, U. S. Army. Describes the work and plant and gives tabulated data of operating records. 1500 w. Eng News—Aug. 26, 1909. No. 7361.

Rock Removal in Hell Gate, New York City. Describes present conditions and the work in progress for the improvement of this dangerous channel. Ills. 4000 w. Eng Rec—Aug. 21, 1909. No. 7307.

Drydocks.

A 6000-Ton Floating Drydock. William T. Donnelly. Illustrated description of a recently completed pontoon floating drydock having a number of new features. 3000 w. Int Marine Engng—Aug., 1909. No. 7118 C.

Flood Protection.

Flood Protection for Breslau (Hochwasserschutz für Breslau). Herr Wannovius. Discusses the problem and its solution. Ills. Serial, 1st part. 1800 w. Deutsche Bau—July 14, 1909. No. 7279 B.

Harbors.

Modern Ships and Harbor Accomodations (Navires et Ports d'Aujourd'hui). Robert Hecker. A description of measures taken in some European ports, including Antwerp, Rotterdam, Havre, Bremerhaven, Southampton and Bremen, to insure the access of the largest of modern ships. Ills. 15000 w. Ann d Ponts et Chaussées—1909-III. No. 7212 E + F.

Italy.

The Development of Internal Navigation in Italy in Relation to the Operation of Railways and Tramways and to National Economy (Considerazioni intorno agli Studi ed ai Mezzi per Sviluppare le Navigazione interna in Relazione coll' Esercizio delle Ferrovie e Tramvie e il Completamento dei Mezzi di Trasporto nell'Interessse dell'Economia Nazionale). Serial, 1st part. 7000 w. Ing Ferro—July 1, 1900. No. 7248 D.

Lighthouses.

The Cayo Caiman Grande Lighthouse, Cuba. Illustrated description of a steel structure nearly 150 feet high, carrying a watch-room and lantern and enclosing a keeper's house at ground level. 900 w. Eng Rec—Aug. 14, 1909. No. 7073.

Locks.

Electrical Installations at the Locks of Port-à-l'Anglais (Installations électriques aux Ecluses le Port-à-l'Anglais). M. Imbs. Detailed description of the electrically operated lock gates, sluices, etc. Ills. Plates. 7200 w. Ann d Ponts et Chaussées—1909-III. No. 7211 E + F.

River Regulation.

Eleventh International Congress of Navigation, St. Petersburg, 1908 (XI[e] Congrès International de Navigation tenu à Saint-Pétersburg en 1908). G. de Joly and R. de la Brosse. General report of proceedings and a detailed report of the discussion on barrages for river regulation. 20000 w. Ann d Ponts et Chaussées—1909-III. No. 7215 E + F.

Shore Protection.

Recent Revetment Construction on the Lower Mississippi River. Clarke S. Smith. Illustration and brief description of the mat construction at Panther Forrest, Ark., recently completed. 1000 w. Eng News—Aug. 26, 1909. No. 7355.

U. S. Waterways.

The Atlantic Coast Waterway. William J. Roe. Maps and discussion of the projected deep water route along the Atlantic coast from Boston to Florida. 3500 w. Naut Gaz—Aug. 26, 1909. Serial, 1st part. No. 7396.

Water Powers.

Relation of the Federal Government to Undeveloped Water Power on Navigable Streams. J. E. Sirrine. Discusses especially the development of water power in the south, and the proper restrictions to be placed on such enterprises. 2500 w. Eng Rec—Aug. 21, 1909. No. 7303.

MISCELLANY.

Aesthetics.

The Aesthetic Treatment of Engineering Construction (Die ästhetische Ausbildung der Ingenieurbauten). Hermann Muthesius. A plea for more regard to aesthetic effect in all sorts of structures. 7000 w. Zeitschr d Ver Deutscher Ing—July 31, 1909. No. 7479 D.

Caisson Disease.

Caisson Disease and Its Prevention. The paper by Henry Japp is discussed. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7369 E.

Dangerous Structures.

Dangerous Structures. E. Willis. Remarks on where the responsibility for such structures rests in England, giving examples and methods of dealing with them. Ills. 4000 w. Surveyor—July 23, 1909. No. 6844 A.

Graphical Computation.

Graphical Computation. E. P. Goodrich. Describes its successful application to the special case of compiling a table of strengths of concrete slabs. 1200 w. Eng Rec—Aug. 21, 1909. No. 7301.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Antennae. G. W. Pickard. Read before The Wireless Inst. Discusses the antennae in present use. 2000 w. Elect'n, Lond—July 23, 1909. No. 6837 A.

The New Telefunken Method of Wireless Telegraphy. W. H. Eccles. An examination of the merits of recent alterations introduced in this system. 2500 w. Elect'n, Lond—July 30, 1909. No. 6976 A.

Radio-Telephony.

Wireless Telephony (La Téléphonie sans Fil). V. Colin. A review of its discovery, development, and present achievements. Ills. 7700 w. Bul Soc Int des Elecns—July, 1909. No. 7208 F.

The Stability of the Poulsen Arc (Remarque sur la Stabilité de l'Arc de Poulsen). C. Tissot. A discussion based on experiments. Ills. 2500 w. Bul Soc Int des Elecns—July, 1909. No. 7209 F.

We supply copies of these articles. See page 156.

Submarine Cables.

Modern Submarine Telegraphy. S. G. Brown. Abstract of a paper before the Roy. Inst. Illustrates and describes the cables now used, the instruments, etc. 3000 w. Elect'n, Lond—July 30, 1909. Serial, 1st part. No. 6978 A.

Telephone Cables.

The Most Economical Combination of Capacity and Inductance in Underground Telephone Cables. B. S. Cohen. A criticism of conclusions reached by M. Devaux-Charbonnel in regard to increased transmission value of low capacity cable. 1500 w. Elect'n, Lond—July 23, 1909. No. 6835 A.

Telephone Time Checks.

Telephone Time Checks (Les Compteurs Téléphoniques). M. Henry. Illustrates and describes a number of typical and novel devices. Serial, 1st part. 4400 w. L'Elecn—July 17, 1909. No. 7220 D.

Telephotography.

A Novel Solution of the Problem of Telephotography. Dr. Alfred Gradenwitz. Brief illustrated description of the "teleautocopist," invented by Laurent Sémat. 700 w. Sci Am—Aug. 21, 1909. No. 7149.

DISTRIBUTION.

Wiring.

The Electrical Equipment of the Mutual Benefit Life Building of Newark, N. J. Illustrated description. 2500 w. Elec Wld—Aug. 19, 1909. No. 7172.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Triple-Frequency Currents in Neutrals of Three-Phase Star Connected Alternators. E. W. Marchant and J. K. Catterson-Smith. Shows how such currents arise, their effects, and indicates means for rendering the effects negligible. 1800 w. Elect'n, Lond—Aug. 6, 1909. No. 7091 A.

A. C. Turbo-Generators.

Tests on a 2500-K.-V.-A. Curtis Turbo-Alternator. A report of tests made at the Aberman Power Station of the Powell Duffryn Co. 600 w. Ills. Engng—July 23, 1909. No. 6854 A.

Commutation.

Commutation in Dynamo Electric Machines. R Rüdenberg. Abstracted from *Elek Zeit.* Considers the important part played by the paths in parallel with the armature coils as they leave short-circuits. 2000 w. Elect'n, Lond. Aug. 13, 1909. No. 7312 A.

Heating.

See Windings, under DYNAMOS AND MOTORS.

Induction Motors.

The Single Phase Induction Motor. R. H. Fenkhousen. Gives the characteristics of this type, with a comparison of various methods of starting. Ills. 1500 w. Power—Aug. 10, 1909. No. 6995.

Application of Induction Motors in Cascade Connection as Compared with Single Multi-Speed Induction Motors. H. C. Specht. Considers the principles of their application by means of examples. 2200 w. Elec Jour—Aug., 1909. No. 7026.

Motor Nomenclature.

Standardization of the Nomenclature of Electric Motors. J. M. Hipple. Gives the classification adopted by electric motor manufacturers, and urges its adoption generally. 1200 w. Elec Jour—Aug., 1909. No. 7027.

Pole-Face Losses.

Pole-Face Losses. Comfort A. Adams, A. C. Lanier, C. C. Pope, and C. O. Schooley. An account of experimental work to establish a reliable relation between the pole-face losses and the principal variables involved. 4500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7056 F.

Victor Diagrams.

The Use of Arrow-Heads in Alternating-Current Victor Diagrams. A. S. Langsdorf. Explanations and examples aiming to remove the confusion often shown by students. 800 w. Elec Wld—Aug. 12, 1909. No. 7015.

Windings.

Determination of the Leakage of Alternating-Current Windings. M. Schenkel. Abstract from *Electrotechnick und Maschinenbau.* Shows how to obtain accurate results. 500 w. Elect'n, Lond—July 23, 1909. No. 6838 A.

Note on the Heating of Magnet Coils. G. Trevor Williams. Experimental separation of heat losses, showing that about one-half are dissipated by convection, and the remainder by radiation and conduction. 1200 w. Elect'n, Lond—Aug. 13, 1909. No. 7313 A.

Temperature Distribution in Magnet Coils of Rectangular Section (Die Temperaturverteilung im Innern von Magnetspulen mit rechteckigem Querschnitt). Karl Humburg. Mathematical. Ills. Serial, 1st part. 2400 w. Elektrotech u Maschinenbau—July 18, 1909. No. 7463 D.

ELECTRO-CHEMISTRY.

Corrosion.

The Corrosion of Metals Underground by Electrolysis. A. A. Kundson. Presents the present state of electrolytic action upon subsurface metals due to railway currents, illustrating the cause and effect. Ills. 4000 w. Jr Fr Inst—Aug., 1909. No. 7031 D.

Electrolytic Corrosion of the Bottom of Oil Tanks and of Other Structures. Adolphus A. Knudson. Read before the Am. Elec.-Chem. Soc. Describes cases of pronounced corrosion in oil tanks, discussing causes and remedies. Ills. 4000 w. Can Engr—Aug. 6, 1909. No. 6937.

Electro-Metallurgy.

Furnace Electrode Losses. C. A. Hansen. Reports experiments made to de-

termine the effect of electrode length on the electrode loss. 1200 w. Elec-Chem & Met Ind—Aug., 1909. No. 6828 C.

Electro-Plating.

The Conditions Which Determine the Composition of Electro-Deposited Alloys. Samuel Field. Abstract of paper read before the Faraday Soc. Investigates the conditions under which brass is deposited from a mixed solution of copper and zinc cyanides. 1500 w. Elect'n, Lond—July 30, 1909. No. 6980 A.

Nitrates.

The Schönherr Process for the Manufacture of Nitric Acid and Nitrates from the Atmosphere (La Fabrication de l' Acide azotique et des Azotates au Moyen de l'Azote atmosphérique, Procédé Schönherr). E. Lemairs. Describes the process and plant of the Badische Anilin- und Soda-Fabrik. Ills. 4800 w. Génie Civil—July 24, 1909. No. 7233 D.

Ozone.

Progress in the Electric Production of Ozone (Neuerungen auf dem Gebiete der elektrischen Ozonerzeugung). Oscar Kausch. A digest of recent patents in this field. Ills. Serial, 1st part. 1000 w. Elektrochem Zeitschr—July, 1909. No. 7256 D.

ELECTRO-PHYSICS.

Alternating Currents.

Polyphase Magnetomotive Forces. J. D. Nies. Derives rules by means of which any step curve can be resolved into sine components, a fundamental and higher harmonics. 3500 w. Elec Wld—Aug. 26, 1909. No. 7352.

Arcs.

On the Electric Arc Between Metallic Electrodes. W. G. Cady and G. W. Vinal. A study of the theory and production of oscillations between arc and glow. 4000 w. Am Jour of Sci—Aug., 1909. Serial, 1st part. No. 7018 D.

The Relighting of the Carbon Arc. J. A. Pollock, E. M. Wellisch and A. B. B. Ranclaud. Abstract from *Phil. Mag.* Investigates the relation between the potential difference across the carbons and the maximum time of interruption of the circuit within which the arc will re-form. 1500 w. Elect'n, Lond—Aug. 13, 1909. No. 7314 A.

Circuit Closing.

Circuit-Closing Phenomena in Capacity-Free Circuits (Ueber Einschaltvorgänge in kapazitätsfreien Stromkreisen). A. Schwaiger. An exhaustive mathematical discussion, with results of tests. Ills. Serial, 1st part. 5500 w. Elektrotech u Maschinenbau—July 4, 1909. No. 7462 D.

Conductivity.

Some Peculiarities of Electrical Conductivity Exhibited by Powders and a Few Solid Substances. R. H. Goddard. Abstract from *Phys. Rev.* Investigates phenomena of conduction and offers a theory in explanation. 3000 w. Elect'n, Lond—Aug. 13, 1909. No. 7315 A.

The Conduction of Electricity. Prof. J. Koenigsberger's views and other researches, explanatory of the ionic theory. 2500 w. Sci Am Sup—Aug. 28, 1909. No. 7380.

Electromagnets.

The Calculation of Electromagnets. M. Kennett. Gives some simple methods of calculating the size of the iron cores, and the winding of their exciting coils. Ills. 4000 w. Sci Am Sup—Aug. 7, 1909. No. 6960.

The Design of the Marcel Deprez Electromagnet. Charles R. Underhill. Discusses the relations between the solenoid and plunger. 1200 w. Elec Rev, N Y—Aug. 7, 1909. No. 6938.

The Weiss Laboratory Electromagnet. M. P. Misslin. Illustrated description of the laboratory magnet designed by Prof. P. Weiss. 1500 w. Elec Wld—Aug. 26, 1909. No. 7353.

Flame.

The Electrical Properties of Flame. Harold Albert Wilson. Read before the Roy. Inst. of Gt. Britain. A study of the conductivity of flame. 2000 w. Elec Engr, Lond—Aug. 6, 1909. No. 7087 A.

Magnetic Properties.

See Bronzes, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

GENERATING STATIONS.

Centralization.

Centralization of Power Supply. Louis A. Ferguson. Presidential address on the advantages of centralization. 2200 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7055 F.

The Supply of Electric Current to Other Towns from a Centrally Located Station. I—O. H. Hutchings. II—Claude Smith. Two papers read before the Ohio Elec. Lgt. Assn. 2500 w. Elec Rev, N Y—Aug. 7, 1909. No. 6940.

Central Stations.

Modern Power Station Design. H. de B. Parsons. The article is confined to steam-driven plants, and considers the essentials of commercial and operative success. 5000 w. Cassier's Mag—Aug., 1909. No. 7034 B.

Central Station Development at Lawrenceville, Ill. Illustrates and describes a reconstructed station, reviewing its history. 2500 w. Elec Wld—Aug. 5, 1909. No. 6902.

Power Improvements of the Coney Island & Brooklyn Railroad Company. Illustrated detailed description of the new power system put in operation Nov. 1, 1908. 3500 w. Elec Ry Jour—Aug. 14, 1909. No. 7047.

Costs.

Labor Costs in Central Stations. Howard S. Knowlton. Analyzes the working

results of nine plants, and the influences affecting economy. 2500 w. Engineering Magazine—Sept., 1909. No. 7418 B.

Results of Central Station Operation (Ueber Ergebnisse aus Elektrizitätswerks-Betrieben). H. Hanszel. Gives curves showing in detail comparative costs in steam, oil and gas stations. Ills. 2800 w. Zeitschr f d Gesamte Turbinenwesen—July 20, 1909. No. 7289 D.

Economics.

The Advantage of Combining a Railway Load with a General Lighting and Power Load (Ueber die Vorteile, welche die Vereinigung von Bahnstromabgabe und allgemeiner Licht- und Kraftversorgung gewährt). Bruno Thierbach. 2800 w. Elek Kraft u Bahnen—July 3, 1909. No. 7459 D.

Hydro-Electric.

The Kilbourn Hydroelectric Plant. Illustrated detailed description of an interesting power development on the Wisconsin River. 4000 w. Elec Rev, N Y—Aug. 28, 1909. No. 7403.

Hydro-Electric Generating Station of the Great Western Power Company on the Feather River. Illustrated description of the development, and of the generating equipment, of interest because of the size. 2000 w. Elec Wld—Aug. 26, 1909. No. 7351.

City of Launceston, Tasmania. Explains four propositions submitted to improve the hydraulic power from the South Esk River. 3500 w. Aust Min Stand—June 30, 1909. No. 6868 B.

The Trollhattan Hydro-Electric Plant, Sweden (L'Usine Hydro-Electrique de Trollhattan, Suède). J. Bally. Illustrated detailed description. 3500 w. Génie Civil—July 3, 1909. No. 7227 D.

The Walchensee Hydro-Electric Plant Competition (Vom Wettbewert um die Walchensee-Wasserkraft-Anlage). Fritz Eiselen. Describes the designs of the six prize winners. Ills. Serial, 1st part. 2000 w. Deutsche Bau—July 21, 1909. No. 7281 B.

LIGHTING.

Illumination.

Modern Methods of Artificial Illumination. Leon Gaster. Introductory remarks with a discussion of types of glow lamps and arc lamps in the present number. Ills. 7500 w. Jour Soc of Arts—Aug. 6, 1909. Serial, 1st part. No. 7081 A.

Incandescent Lamps.

The Forerunners of the Metallic Filament Incandescent Lamp. Dr. C. Richard Böhm. Reviews the experiments made, with a view to utilize rare earths. 1200 w. Engr, Lond—Aug. 6, 1909. No. 7109 A.

Modern Incandescent Electric Lamps. A. C. Jolley. An account of tests at the photometric laboratory of the Northampton Inst., to obtain a fair comparison of the carbon filament and modern metallic filaments. 1200 w. Elect'n, Lond—Aug. 13, 1909. Serial, 1st part. No. 7311 A.

Photometric Units.

The Proposed International Unit of Candle Power. C. C. Paterson. Read before the *Phys. Soc.* A comparison of British, American, French and German units. 2800 w. Elect'n, Lond—Aug. 13, 1909. No. 7316 A.

MEASUREMENT.

Capacity.

Measurement of Capacity and Self Induction (Etalonnement des Capacités et des Self-Inductions). MM. Decoin and Devaux-Charbonnel. Describes a simple method and apparatus used by the authors. Ills. 3000 w. L'Elecn—July 10, 1909. No. 7219 D.

Electrometer.

A String Electrometer. T. H. Laby. Abstracted from Pro. of Cambridge Phil. Soc. Describes a simple form of string electrometer and tests made. 800 w. Elect'n, Lond—Aug. 20, 1909. No. 7429 A.

Galvanometers.

A Bifilar Vibration Galvanometer. W. Duddell. Abstract of a paper read before the Phys. Soc. A new type and a series of tests made upon it are described. 1500 w. Elect'n, Lond—July 30, 1909. No. 6977 A.

Hysteresis Loss.

Differential Testing for Hysteresis Loss. Ernest Wilson. A report of experimental investigations. 1000 w. Elect'n, Lond—July 23, 1909. No. 6836 A.

Instruments.

Hot-Wire Ammeter for Currents of High Frequency and Tension (Ampèremètre thermique pour Courants de forte Intensité et de grande Fréquence). M. Broca. Illustrated description of an invention of the author. 1400 w. Bul Soc Int des Elecns—July, 1909. No. 7207 F.

Ohmmeters and a New Universal Apparatus for the Direct Reading of Volts, Amperes and Ohms (Ueber Ohmmeter und einen neuen Universalapparat, der Spannung, Stromstärke und den Widerstand direkt abzulesen gestattet). Egon Siedek. Illustrated description. Elektrotech u Maschinenbau—July 18, 1909. No. 7464 D.

Meter Connections.

Connections for a Single-Phase Wattmeter on a Three-Phase, Three-Wire System. F. Conrad. Explains two methods in general use. Diagrams. 1800 w. Elec Wld—Aug. 19, 1909. No. 7173.

Meters.

Meters. Burleigh Currier. An elementary explanation of their underlying principles and methods of testing. 6500 w. Elec Age—July, 1909. Serial, 1st part. No. 6917.

The Effect of Short Circuits on Watt-Hour Meters. A. L. Goetz. Graduation

thesis. A report of experimental investigations and conclusions. 1200 w. Am Gas Lgt Jour—Aug. 9, 1909. No. 6931.

See also Shop Practice, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Meter Testing.

Importance of Testing Meters. H. W. Richardson. Gives instances illustrating the benefits derived from metering, and shows the necessity of testing the meters. 2500 w. Elec Wld—Sept. 2, 1909. No. 7589.

Reograph.

Application of the Rheograph to the Study of Various Phenomena (Application du Rhéographe à l'Etude de Divers Phénomènes). Henri Abraham. Description of the construction and uses of this curve-tracing device devised by Abraham and Charpentier. Ills. 5000 w. Bul Soc Int des Elecns—July, 1909. No. 7210 F.

Self-Induction.

See Capacity, under Measurement.

POWER APPLICATION.

Blowing Engines.

See same title, under MINING AND METALLURGY, Iron and Steel.

Elevators.

See same title, under MECHANICAL ENGINEERING, Transporting and Conveying.

Lock Gates.

See Locks, under CIVIL ENGINEERING, Waterways and Harbors.

TRANSMISSION.

Cable Laying.

Two Useful Cable-Laying Appliances. C. A. Smith. Brief illustrated descriptions of a cable drum carriage, and a special duct reel, made by the writer. 700 w. Elec Rev, Lond—Aug. 20, 1909. No. 7434 A.

Cables.

Losses, Induced Volts and Amperes in Armor and Lead Cover of Cables. H. W. Fisher. Supplementary to J. B. Whitehead's paper, presenting data obtained from measurements made on the same cables. Also further tests. 800 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7062 F.

Insulation.

Insulating Materials. Thomas Germann and Stanley M. Hills. From a paper read before the Jun. Inst. of Engrs. Considers the properties and requirements of a good insulator. 3000 w. Elec Engr, Lond—July 30, 1909. No. 6974 A.

Insulators.

Discussion on "Condenser Type of Insulation for High-Tension Terminals," and "High Voltage Transformers and Protective and Controlling Apparatus for Outdoor Installation," New York, April 9, 1909. The papers by A. B. Reynders and by K. C. Randall are discussed. Ills 13500 w. Pro Am Inst of Elec Engrs—Aug. 1, 1909. No. 7050 F.

Insulators for Transmission Lines (Freileitungsisolatoren). M. Gerstmeyer. Discusses the requirements of a satisfactory high-tension insulator, methods of testing, etc. Ills. Serial, 1st part. 3500 w. Elek Kraft u Bahnen—July 3, 1909. No. 7460 D.

Line Construction.

Overhead Wires. William Copeland. Suggestions for their erection. 1200 w Elec Rev, Lond—July 23, 1909. No. 6833 A.

Line Repairs.

Repairing High-Voltage Lines While in Service. J. S. Jenks and W. H. Acker. Describes methods of working on ungrounded lines in service. 3000 w. Elec Wld—Aug. 5, 1909. No. 6904.

Lines.

See Rio Janeiro, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Regulation of Potential Transformers and the Magnetizing Current. M. G. Lloyd and P. G. Agnew. Shows that the current has an inappreciable effect upon the regulation. 2000 w. Elec Rev, N Y—Aug. 7, 1909. No. 6939.

Dimensions of Single-Phase Core and Shell Transformers, with Copper and Iron Circuits of Uniform Rectangular Cross-Section. A. R. Low. Read before the Inst. of Elec. Engrs. Mathematical. 2000 w. Elec Engr, Lond—Aug. 13, 1909. No. 7198 A.

"C. M. B." Patent Direct Current Rotary Transformer. J. C. Macfarlane and H. Burge. Describes construction and discusses applications of a new type of rotary electric transforming machine. 3000 w. Elec Rev, Lond—July 23, 1909. No. 6832 A.

See also Insulators, under Transmission.

MISCELLANY.

Accidents.

Electrical Accidents Around Machinery and Their Prevention. Robert J. Young. Briefly considers dangers from shocks, burns, flashes, and falls, and the precautions found effective. Ills. 1000 w. Elec Wld—Aug. 12, 1909. No. 7014.

The Dangers of Electrical Transmission Lines and Apparatus and Necessary Precautions for Safety (Des Dangers des Canalisations et Appareils électriques et des Précautions à Prendre). A Meynier. A general review of dangers of electric shocks and suggestions for preventing accidents. 4500 w. L'Elecn—July 17, 1909. No. 7221 D.

Symbols.

A Contribution to the Statistics of International Electrical Engineering Symbology. A. E. Kennelly. Gives tabulated results of an examination into the notation of recent text-books from France, Germany, Great Britain, Italy and the United States. 1800 w. Elec Wld—Aug 12, 1909. No. 7013.

We supply copies of these articles. See page 156.

INDUSTRIAL ECONOMY.

Cost Systems.

A Simple Foundry Production Tally. C. E. Knoeppel. Describes a practical cost system for the casting shop. 5000 w. Foundry—Aug., 1909. No. 6814.

The Distribution of Foundry Tonnage Burdens. Victor R. Claydon. Brief discussion of an interesting problem in accurate determination of costs. 600 w. Engineering Magazine—Sept., 1909. No. 7421 B.

Education.

The Training of Non-Technical Men. C. R. Dooley. Discusses the need of trained men, and the work of the apprenticeship system, and of the night school in the training of non-technical men. 2500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7057 F.

Discussion on "Fundamental Principles of Industrial Education," New York, April 16, 1909. The paper by Herman Schneider is discussed. 12500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7060 F.

Training in the Engineering Trades in Philadelphia. Henry W. Spangler. Discusses present conditions and opportunities, and the trade-school training that should be provided. 7000 w. Pro Engrs' Club of Phila—April, 1909. No. 7115 D.

Lane Technical High School, Chicago. Explains the functions of this school, the studies and equipment, etc. Ills. 3500 w. Elec Wld—Aug. 26, 1909. No. 7354.

The Rensselaer Polytechnic Institute and the Development of Engineering Education. Extracts from the address of Jesse M. Smith, at the dedication of the new Russell Sage laboratory building, 1200 w. Eng News—Aug. 19, 1909. No. 7137.

The Merchant Venturers' Technical College, Bristol. Illustrate and describes the electrical equipment of the new building. 2500 w. Elect'n, Lond—July 30, 1909. Serial, 1st part. No. 6979 A.

Engineering.

Engineering Science and the "Practical Man" in Engineering. Antonio Llano. A criticism of the "practical" attitude of some engineers. 5500 w. Eng News—Aug. 19, 1909. No. 7140.

Experiment Station.

See Illinois Industries, under INDUSTRIAL ECONOMY.

Illinois Industries.

The Engineering Experiment Station and Its Relation to Illinois Industries. L. P. Breckenridge. Explains the great resources of this state, outlining their development, and showing graphically and by charts the growth and general advancement. Also an illustrated account of the work of the engineering experiment station of the University of Illinois and its influence. Discussion. 12800 w. Jour W Soc of Engrs—Aug., 1909. No. 7423 D.

Industrial Districts.

The Centering of Great Industries in the New York Metropolitan District. Dr. Charles F. McKenna. Extracts from a paper at meeting of the Am. Inst. of Chem. Engrs. Gives statistics showing the importance of this district and discusses steps that would lead to the best development and advancement. 5000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6822 C.

Labor Insurance.

Labor Insurance in Germany (Aus den Ergebnissen der Statistik der deutschen Arbeiterversicherung). Otto Graf. Summary of statistics showing the cost and results of labor insurance. Ills. Serial, 1st part. 2400 w. Technik u Wirtschaft —July, 1909. No. 7472 D.

Management.

Graphical Helps for Apportioning Time in Constructive Operations. Herbert F. Stimpson. Considers exact predetermination as necessary for time as for material. 2000 w. Engineering Magazine—Sept., 1909. No. 7419 B.

Patents.

Discussion on "The Patent System in Its Relation to Industrial Development." New York, May 18, 1909. Discusses Frederick P. Fish's paper. 5000 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7061 F.

Inventing and Patenting—A Will o' the Wisp. L. P. Alford. Gives results of an investigation which shows the average cost of a patent to be $570, and that less than one invention in four pays back the cost. 4000 w. Am Mach—Vol. 32, No. 31. No. 6894.

Public Utilities.

A Dividing Scale for Charging for Public Utilities. W. D. Marks. Presents the writer's solution of this problem. 1200 w. Eng News—Aug. 26, 1909. No. 7360.

Tariff.

The Metal Schedule in Its Final Shape. Gives the text of Schedule C of the new tariff bill. 7800 w. Ir Age—Aug. 5, 1909. No. 6893.

Tariff Duties Compared. A comparison of the metal duties in the Dingley act with those in the new law. Also other provisions of interest to the metal trades. 6000 w. Ir Age—Aug. 12, 1909. No. 7000.

We supply copies of these articles. See page 156.

MARINE AND NAVAL ENGINEERING.

Barges.

Reinforced Concrete Boats. H. Prime Kieffer. Illustrates and describes a construction coming into extensive use in Italy. 2200 w. Int Marine Engng—Aug., 1909. No. 7117 C.

Battleships.

Battleships (Navi da Battaglia). E. Ferretti. An examination into the conditions of their maximum efficiency in action, discussing armor, armament, speed and ability to manœuvre. 10000 w. Riv Marit—July-Aug., 1909. No. 7236 E + F.

British Navy.

The Single Corps of Engineers (Il Corpo Unico). A Levi-Bianchini. A discussion from the Italian standpoint, of the abolition of the "naval engineers" in the British navy. 28000 w. Riv Marit—July-Aug., 1909. No. 7235 E + F.

Dredges.

A Combination Dipper and Clam-Shell Bucket Dredge. Frank Eder. Illustrated description. 1200 w. Int Marine Engng—Aug., 1909. No. 7119 C.

The Hopper and Suction Dredge "Venezia." Illustration and description of a seagoing dredge constructed for the Italian Government. 1000 w. Engng—Aug. 13, 1909. No. 7327 A.

Electric Power.

The Electro-Mechanical Propulsion of Ships. A. P. Chalkley. Reviews some systems of electric propulsion tried or proposed. The design of Mr. Mavoe is especially considered. 2000 w. Elec Rev, Lond—July 23, 1909. Serial, 1st part. No. 6834 A.

Ferryboats.

The Ferry. Miss Vandenberg, H. F. Bennett and L. E. Baldt. Plans and description of a double-end ferryboat propelled by internal combustion engines. For service on the St. Lawrence River. 1200 w. Int Marine Engng—Aug., 1909. No. 7120 C.

I. The Swedish State Railway Ferry Steamer "Malmo." II. Danish State Railway Steam Ferry "Christian IX." Illustrates and describes those two vessels as types of those used in the service between Sweden and Denmark. 1600 w. Engng—July 23, 1909. No. 6850 A.

Gas Engines.

A Successful Marine Producer-Gas Plant. Describes the plant installed on the motor boat "Marenging," and reports concerning its operation and economy. 1000 w. Int Marine Engng—Aug., 1909. No. 7121 C.

Guns.

Hydraulic or Electric Power for the Operation of Guns (Impianti di Artiglierie: Idraulici od Elettrici?). G. Pecori-Giraldi. A discussion of their relative advantages. Ills. 6800 w. Riv Marit—July-Aug., 1909. No. 7237 E + F.

Hydroplanes.

Skimming Boats. C. Johnstone. Illustrated review of recent developments in high-speed hydroplanes. 2000 w. Cassier's Mag—Aug., 1909. No. 7035 B.

Hydroplane or Skimming-Boats. Brief account of the Thornycroft boat and results obtained with it. 1200 w. Engng—July 23, 1909. No. 6853 A.

"Tadpole"—Sir John Thonycroft's New Skimming Boat. Illustrates and describes a combination of boat and hydroplane which skims at 30 miles an hour. 2000 w. Auto Jour—July 24, 1909. No. 6829 A.

Marine Transport.

Britain's Place in the World's Shipping. Editorial review of information from a recent issue of Lloyd's Register, which shows that in respect to volume, and high-speed, and large capacity ships Britain holds the most prominent place. 1200 w. Engng—July 23, 1909. No. 6851 A.

Model Basins.

Model Basins (Einiges über Schiffsmodell-Versuchsanstalten). A. Schromm. Brief notes on existing model basins, their cost, methods of investigation, etc. 2600 w. Oest wochenschr f d Oeffent Baudienst—July 10, 1909. No. 7456 D.

Motor Boats.

A Record Cross-Country Motor-Boat Trip. An illustrated account of a river trip from Pittsburg to Cincinnati. 2000 w. Sci Am—Aug. 21, 1909. No. 7147.

See also Gas Engines, under MARINE AND NAVAL ENGINEERING.

Oil Engines.

The Diesel Motor for Marine Propulsion in Russia (Der Dieselmotor als Schiffsmaschine in Russland). Herr Murauer. Discusses advantages, describes installations and gives results. Ills. 5000 w. Schiffbau—July 28, 1909. No. 7286 D.

See also Ferryboats, under MARINE AND NAVAL ENGINEERING; and Oil Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Propulsion.

The Advance of Marine Engineering in the Early Twentieth Century. Arthur J. Maginnis. Reviews the rapid progress in the adoption of the steam turbine for marine propulsion. Discusses the electric drive, liquid fuel, internal-combustion engines. 6000 w. Inst of Mech Engrs—July, 1909. No. 7090 N.

Repair Ship.

H. M. S. Cyclops, Floating Repair Shop for the Navy. Illustrated detailed de-

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scription of this floating workshop. Plates. 5600 w. Engr, Lond—July 23, 1909. No. 6856 A.

Salvage.

Raising Standard Oil Barge No. 91. Illustrated detailed description of the methods used to raise this vessel which sank just inside the Columbia River bar. 1500 w. Marine Rev—Aug., 1909. No. 7048.

The Salvage of the Steamer "Fleswick." Illustrates and describes in detail methods used in raising a steamer sunk in Cork harbor, by using compressed air, pumped into the holds after making them air-tight. 2500 w. Engng—July 30, 1909. No. 6985 A.

Shipbuilding.

Shipbuilding of Yesterday and To-day. George Leslie. Reviews the changes in material, design, and construction. 1500 w. Cassier's Mag—Aug., 1909. No. 7033 B.

Ship Repairs.

Repairing the Crushed-in Bow of the Florida. Illustrations and brief account of the effect of the collision and the repairs made. 1000 w. Sci Am—Aug. 28, 1909. No. 7378.

Steam Engines.

The Comparative Weights of Reciprocating and Turbine Machinery for Marine Work. N. W. Greenway. Gives tabulated data showing the increased h. p. per ton of machinery weight in various classes of vessels, with discussion of the subject. 1000 w. Engng—Aug. 13, 1909. No. 7329 A.

The Combination of Reciprocating and Turbine Engines. W. McK. Wisnom. Read at joint meeting in Glasgow. Notes on the trials and performance of the S.S. "Otaki," fitted with a combination of reciprocating and turbine machinery. Ills. 4500 w. Engng—Aug. 6, 1909. No. 7106 A.

Steam-Engine Pipe Arrangements. E. Herbert. A large marine engine is taken as an example to illustrate the arrangement of pipes, valves, connections, etc. 1200 w. Mech Wld—Aug. 13, 1909. No. 7321 A.

Machinery of the Italian Battleship Napoli. Illustrated description of the propelling machinery of this recently completed vessel. Plate. 1000 w. Engr, Lond—Aug. 20, 1909. No. 7484 A.

Steamships.

The Coal Steamer "John Heidmann" (Kohlendampfer "John Heidmann"). Illustrated description with detailed plates. 1000 w. Schiffbau—July 14, 1909. No. 7285 D.

Steam Turbines.

On the Adaptation of Steam Turbines for the Propulsion of Vessels at Moderate Speeds. Yasuzo Wadagaki. A study of this problem, with explanation of the system evolved by the author, discussing its advantages and disadvantages, and reporting experiments. Short discussion. Ills. 5000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—July, 1909. No. 7024 N.

Experiences with Parsons Marine Steam Turbines in Comparison with Reciprocating Engines (Einige Erfahrungen mit Parsons-Marine-Dampfturbinen im Vergleiche mit Kolbendampfmaschinen). Carl Fred Holmboe. Gives a resumé of recent results with turbine-driven vessels. Ills. 2800 w. Zeitschr f d Gesamte Turbinenwesen—July 10, 1909. No. 7288 D.

Cruising Turbines on War Ships Driven by Reaction Turbines (Le Turbine di Marcia a Bordo delle Navi da Guerra Mosse con Turbine a Reazione). G. Belluzzo. A brief mathematical note on their design. Ills. 2300 w. Industria—July 11, 1909. No. 7241 D.

7400-Horse-Power Zoelly Marine Turbine. Data, particulars and illustrations of the design. 700 w. Engng—Aug. 13, 1909. No. 7325 A.

The Schulz Turbine (Die Schulz-Turbine). Carl Züblin. Describes the latest design for marine purposes and gives test results. Ills. 2800 w Schiffbau—July 14, 1909. No. 7284 D.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Submarines.

Twenty Miles Under the Sea. Editorial giving an account of a run below the surface of the water, in a submarine. 1500 w. Sci Am—Aug. 21, 1909. No. 7145.

Develop the Submarine! Edwin Swift Balch. A brief discussion of the naval problem of the present, and the importance of the submarines in harbor defense, urging the United States to follow the lead of Great Britain and France in the development of the submarine. 2500 w. Jr Fr. Inst—Aug., 1909. No. 7030 D.

Survey Vessels.

The Nonmagnetic Ship "Carnegie." E. A. Dixie. Illustrated description of vessel built for the investigation of terrestrial magnetism. 3000 w. Am Mach—Vol. 32, No. 34. No. 7346.

Torpedoes.

Torpedo Attack. A brief illustrated account of recent tests made by the Italian government. 800 w. Engng—Aug. 13, 1909. No. 7330 A.

Torpedo Testing.

The Schneider Torpedo-Testing Station. Illustrations and description of a proving-station, on the French coast, for testing automobile torpedoes. 4000 w. Engng—Aug. 6, 1909. No. 7104 A.

U. S. Navy.

The Naval Waste. The first of a series of articles on the naval administration of the United States. 3500 w. Marine Rev—Aug., 1909. Serial, 1st part. No. 7049.

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MECHANICAL ENGINEERING.

AUTOMOBILES.

Benz.

The Latest Mannheim Production. Illustrated description of the leading features in the 18 h. p. Benz engine. 700 w. Auto Jour—Aug. 7, 1909. No. 7083 A.

Carburetters.

Experiments with a Glass Carburetter. J. S. V. Bickford. Diagrams and description of experimental investigations. 3500 w. Engr, Lond—Aug. 6, 1909. No. 7108 A.

Chalmers-Detroit.

Chalmers-Detroit 1910 Presentation. Illustrates and describes new features introduced. 2000 w. Automobile—Aug. 19, 1909. No. 7157.

Commercial Vehicles.

Energy Consumption of Commercial Vehicle. Alex. Churchward. Read at meeting of Soc. of Auto. Engrs. Deals with the principal factors influencing the required horse-power. 1000 w. Automobile—Aug. 12, 1909. No. 7041.

On the Subject of Commercial Vehicle Bodies. Morris A. Hall. Illustrated discussion of the causes which determine the type of body fitted to machines for carrying freight or passengers. 3000 w. Com Veh—Aug., 1909. Serial, 1st part. No. 6874 C.

Getting Familiar with the Motor Truck. Stanley Rosebery. A discussion of the parts of the gas motor truck and their functions. Ills. 3500 w. Com Veh—Aug., 1909. No. 6875 C.

Corbin.

Corbin Appears in 1910 Form. Details of changes in the new models are given, describing the different types. Ills. 2200 w. Automobile—Aug. 26, 1909. No. 7377.

Dennis.

The 18 h. p. Four-Cylinder Dennis. Illustrated description of a medium-powered car embodying the worm drive. 1200 w. Autocar—July 24, 1909. No. 6831 A.

Electric.

Operation and Care of Vehicle Batteries. H. M. Beck. Read at meeting of Soc. of Auto. Engrs. Detailed discussion of care needed by storage batteries, and explanation of their operation. 4000 w. Automobile—Aug. 12, 1909. No. 7040.

The Relations Between Central Stations and the Electric Automobile. A summary of replies to questions sent out, giving data in regard to the charging of electric vehicles. 9500 w. Elec Wld—Aug. 5, 1909. No. 6905.

Farm Motors.

See Tractors, under AUTOMOBILES.

Garages.

Efficient Equipment of Private Motor Houses. Explains the value of a few special machines. Ills. 1200 w. Auto Jour—July 31, 1909. No. 6965 A.

Gear Testing.

Testing Gear for Automobiles. M. E. Hidiegan. Illustrated description of a device for the final testing of all spur-cut gears, either soft or hardened. 1000 w. Am Mach—Vol. 32, No. 34. No. 7350.

Ignition.

Dry Cells and the Advantages of Multiple Batteries for Ignition. A. L. Haskell. Read before the Nat. Gas Eng. Trds. Assn. Explains what has been accomplished in the manufacture of dry batteries and the applications where they have proved satisfactory. 4500 w. Gas Engine—Aug., 1909. No. 7021.

Multi-point Ignition. R. W. Ayton. An explanation by the originator. 1800 w. Autocar—Aug. 7, 1909. No. 7086 A.

How I Fitted a Magneto to a Small Runabout. Joseph Tracy. Drawings and description. 1000 w. Automobile—Aug. 19, 1909. No. 7155.

Laurin-Klement.

An Austrian Twin-Cylinder Runabout. Illustrates and describes the 10-h. p. Laurin-Klement car. 500 w. Auto Jour—Aug. 14, 1909. No. 7196 A.

Lighting.

Head-Lamps at the Crystal Palace. Reports of efficiency and of non-dazzling properties. Ills. 2500 w. Auto Jour—July 24, 1909. No. 6830 A.

Lubrication.

Grease or Oil in Transmission Gears? H. L. Towle. A discussion of the effectiveness of the two lubricants for this use. Ills. 2000 w. Automobile—Aug. 19, 1909. No. 7154.

Metallurgic.

A Long-Stroke Twenty-Six. An illustrated description of the latest four-inch metallurgic. 1500 w. Auto Jour—July 31, 1909. No. 6964 A.

Motobloc.

The 14-H. P. Motobloc Petrol Car. Brief illustrated description. 600 w. Auto Jour—Aug. 14, 1909. No. 7195 A.

Motor Exhausts.

Exhaust Pipe Arrangement. Considers the effect of the exhaust on the engine. Ills. 1500 w. Autocar—Aug. 7, 1909. No. 7085 A.

Motors.

A Five-Cylinder Engine and Gearless Car. Section and description of the invention of A. Gore, with explanation of how he has been able to make forced induction a success. 2200 w. Autocar—July 31, 1909. No. 6966 A.

Liquid-Fuel Motors (Fahrzeugmaschinen für flüssigen Brennstoff). A. Hel-

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ler. A general review of the design and construction of automobile, motor boat, motor car, and airship motors. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—July, 24, 1909. No. 7474 D.

Motor Testing.

Tests of High-Speed Combustion Motors (Essai des Moteurs à Explosion à grande Vitesse). J. Izart. Describes the apparatus and methods used by M. Rinzelman. Ills. 2000 w. L'Elecn—July 24, 1909. No. 7222 D.

Pope-Hartford.

Pope-Hartford Model T for 1910. A 4-cylinder, 40-h. p. car to be made in six body types. 1500 w. Automobile—Aug. 12, 1909. No. 7042.

Reo.

Four Cylinder Reo Makes Its Bow. Illustrated description of a new design, known as Model R, rated at 30-35 h. p. 6000 w. Automobile—Aug. 5, 1909. No. 6916.

Repairs.

Ingenuity in the Making of Repairs. Oliver Light. Sketches and suggestions for making quickly various automobile repairs. 2000 w. Automobile—Aug. 26, 1909. No. 7376.

Steering.

Notes on Steering Mechanism. Diagrams and discussion of some of the problems encountered. 3500 w. Autocar—Aug. 14, 1909. No. 7194 A.

Thomas.

Thomas Flyer Model "M" 6-40 Touring Car. Illustrates and describes the latest model of the Thomas cars, which will have long-stroke motor. 2200 w. Automobile—Aug. 19, 1909. No. 7156.

Tractors.

Gas Motor Tractors for Agricultural Work. Henri Godefroy. Illustrates and describes types of machines used for agricultural purposes in the United States and abroad. 3500 w. Con Veh—Aug., 1909. Serial, 1st part. No. 6873 C.

Mechanical Transport in the Colonies. Information from a recently issued Blue Book relating to the possibility of using mechanical transport on the roads in undeveloped regions, price of fuel, water supply, rates of labor and particulars bearing on this subject. 1600 w. Engng—Aug. 13, 1909. No. 7328 A.

Wheels.

Handling Detachable Rims. Illustrated directions for replacing inner tubes and outer covers. 800 w. Auto Jour—Aug. 7, 1909. No. 7084 A.

Determination of the Diameter and Weight of Automobile Wheels (Détermination du Diamètre et du Poids des Roues). E. Girardault. Discusses the principles of the design of wheels for automobile vehicles for special purnoses. Ills. 5000 w. Génie Civil—July 10, 1909. No. 7230 D.

COMBUSTION MOTORS.

Gas-Engine Compression.

Determining the Actual Compression in a Small Gas Engine. George M. Strombeck. Directions for obtaining the compression. 900 w. Mach, N Y—Aug., 1909. No. 6807 C.

Gas-Engine Indicators.

Indicating of Gas-Engines. Frederic W. Burstall. Gives comparative results obtained by using simultaneously an indicator of the ordinary string type, and an optical indicator. Ills. Tables. 1500 w. Inst of Mech Engrs—July. 1909. No. 6990 N.

Gas Engines.

Recent Improvements in the Internal-Combustion Engine. H. E. Wimperis. A summary of what has been accomplished, stating the problem and the lines along which its solution has been attempted. 2000 w. Nature—Aug. 5, 1909. Serial, 1st part. No. 7080 A.

Gas Engine and Gas Producer. Percival Robert Moses, in *The Isolated Plant.* Showing the present gas engine to be a standard apparatus, both economical and efficient. 2500 w. Gas Engine—Aug., 1909. No. 7022.

The Small Two-Stroke Gas Engine. Walter C. Willard. Explains its possibilities in the industrial field and discusses its limitations. Ills. 1800 w. Ind Engng—Aug. 15, 1909. No. 7177 C.

Gas Producers.

The Generation of Producer Gas. Oskar Nagel. Detailed discussion of the gasification of different fuels. 2000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6827 C.

The Utilization of Low-Grade Fuels in the United States. Dr. O. K. Zwingenberger. Read before the Am. Inst. of Chem. Engrs. Reviews European practice and discusses especially the proper design of gas-producers for low-grade fuels. Ills. 4000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6825 C.

Suctions Gas Producer for Bituminous Fuel: Morton's Patent. Illustrated description, with report of tests. 1500 w. Col Guard—July 30, 1909. No. 6981 A.

Experience with Suction Gas Producers. Notes from actual experience in the manufacture and working of suction-gas plants. 2500 w. Engr, Lond—July 23, 1909. Serial, 1st part. No. 6857 A.

Scoby-Smith's Gas Producer. Illustrated description of a gas producer for use in melting and heating steel. 600 w. Mech Engr—July 30, 1909. No. 6971 A.

Gas Turbines.

See Turbines, under STEAM ENGINEERING.

Oil Engines.

Development and Extension of the Use of Diesel Motors in Russia and their Application to Ship Propulsion (Die Entwicklung und Verbreitung des Diesel-

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motors in Russland und seine Verwendung als Schiffsmotor). R. Murauer. Describes some of the latest designs. Ills. Serial, 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7476 D.

Thermodynamics.

Internal-Combustion Engines (Ueber Verbrennungskraftmaschinen). Alfred Büchi. Begins an elaborate discussion of the thermodynamics of gas, gasoline and oil engines. Ills. Serial, 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen —July 20, 1909. No. 7290 D.

HEATING AND COOLING.

Air Washing.

An Investigation of Air Washing. Preliminary report of the Committee of the Am. Soc. of Heat. & Vent. Engrs. on types of air washers and their effect. 800 w. Heat & Vent Mag—Aug 1909. No. 7097.

Hot-Air Heating.

A Combination Heating System in Malone, N. Y. Plans and description of a satisfactory system in which the main parts of the house are heated by warm air, and the more exposed rooms are warmed by hot water radiation. 2000 w. Mel Work—Aug. 14, 1909. No. 7063.

Hot-Water Heating.

A New Rapid Circulation Hot-Water Heating System. Describes the Turul system and its operation. Ills. 2500 w. Heat & Vent Mag—Aug., 1909. No. 7098.

See also Hot-Air Heating, under HEATING AND COOLING.

Humidity.

The Humidity of the Air and Its Determination. M. F. Thomas. Deals with methods and data for determining the moisture content. Plate. 1600 w. Met Work. Aug. 21, 1909. No. 7175.

Liquid Air.

Liquid Air and the Properties of Bodies at Low Temperatures (El Aire liquido y las Propiedades de los Cuerpos á bajas Temperaturas). Horacio Damianovich. An exhaustive study of the production, properties and uses of liquid air and its services in scientific investigation. Ills. 14000 w. Anales d l Soc Cien Argentina —Feb., 1909. No. 7252 E + F.

Refrigeration.

Modern Commercial Uses of Refrigeration. An illustrated article presenting the benefits from the application of refrigeration in the meat industry. 3500 w. Ice & Cold Storage—Aug., 1909. Serial, 1st part. No. 7064 A.

Refrigeration Installation and Narrow Limits of Temperature. Editorial on the advance made in this field, especially as applied to ships' cargoes of perishable materials. 1500 w. Engng—July 30, 1909. No. 6987 A.

Federal Regelation System of Ice Making. Illustrated description of the construction and operation of the first ice-making plant on this system in America, located at Newark, N. J. 2000 w. Ice & Refrig—Aug., 1909. No. 6879 C.

Steam Loop.

See same title, under STEAM ENGINEERING.

Steam Pipes.

The Pitch of Heating Pipes. Charles B. Starkey. Discusses points relating to steam pipe lines and their proper amount of pitch. 1200 w. Dom Engng—Aug. 14, 1909. No. 7096.

Ventilation.

Modern Practice in Heating and Ventilation (Die jetzige Bewegung auf dem Gebiete der Heizungs und Lüftungstechnik). M. Haller. A general discussion of the more important features. 5500 w. Gesundheits-Ing—July 24, 1909. No. 7297 D.

Air Purification by Ozone (Die Verwendung von Ozon zur Luftreinigung). W. Cramer. Describes apparatus for the production of ozone, methods of introducing ozone into the air of rooms, etc. Ills. 4500 w. Gesundheits-Ing—July 17, 1909. No. 7296 D.

The Removal of Humidified Air from Rooms (Zur Berechnung von Entrebelungsanlagen). Paul Pakusa. A theoretical discussion of the design of devices for this purpose. 5000 w. Gesundheits-Ing—July 10, 1909. No. 7294 D.

Auditorium Ventilation (Die Lüftung der Säle). Ernest Schiele. A study of the ventilation of large halls. Ills. 11000 w. Gesundheits-Ing—July 17, 1909. No. 7295 D.

HYDRAULIC MACHINERY.

Air Lift.

Efficiency of the Air Lift as a Solution Pump. Leonard M. Green. Explanation of the theory, giving applications. Thinks a minimum efficiency of 70 per cent. should be attained. 2200 w. Eng & Min Jour—Aug. 7, 1909. No. 6942.

Centrifugal Pumps.

The Output of Centrifugal Pumps and Water-Lifting Wheels (Die Leistungen von Kreiseln und Schöpfrädern). H. Hagens. Considers a number of examples of both classes of water-lifting apparatus. Ills. Serial, 1st part. 6600 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7465 D.

Electric Pumps.

See Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Pumping Stations.

Test of Large Sewage Pumping Station. Simpson Rice. Illustrates and describes the 39th Street station in Chicago, and the methods employed to determine the volume of sewage and water pumped and average head. 3000 w. Power—Aug. 3, 1909. No. 6819.

Turbine Plants.

Water-Power Plant and Poppenweil

Rolling Weir on the Neckar (Wasserkraftanlage und Walzenwehr Poppenweiler am Neckar). Wilhelm Müller. Illustrated description of the plant and its construction. Serial, 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—July 30, 1909. No. 7291 D.

Turbines.

Characteristics of Modern Hydraulic Turbines. Chester W. Larner. A study by means of tests, of the characteristics of several types, indicating in a general way the conditions of service for which they are adapted. Ills. 10500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7367 E.

Water-Lifting Wheels.

See Centrifugal Pumps, under HYDRAULIC MACHINERY.

MACHINE ELEMENTS AND DESIGNS.

Clutches.

Principles in Design of Friction Clutches. J. Richards. Considers the proper time interval for engaging the clutch, and suggests a construction embodying this feature. Ills. 2500 w. Am Mach—Vol. 32. No. 33. No. 7167.

Gears.

Efficiencies of Various Cut Gears. G. Everett Quick. Describes apparatus used and gives results obtained in testing automobile spur, bevel, worm and crown gears. Ills. 1700 w. Am Mach—Vol. 32. No. 33. No. 7166.

Bevel Gear Tables. Charles Watts. Tables for the convenience of engineers and draughtsmen, with explanatory notes. 1000 w. Engr, Lond—Aug. 13, 1909. No. 7331 A.

Simplified Gear Formulas. C. R. Whittier. Gives a three quadrant gear chart for the rapid solution of spur and bevel gear problems, based on Lewis formula, with explanation. 1500 w. Mach, N Y—Aug., 1909. No. 6803 C.

Machine-Cut Double-Helical Gears. Perry C. Day. Explains the advantages of this type of gear and the methods of cutting and applications. Ills. 4000 w. Am Mach—Vol. 32. No. 32. No. 7008.

Graphical Charts.

Curves for Engineering Calculations. J. M. Spitzglass. Describes a method of plotting and combining curves, explaining their value as time savers. 2500 w. Power—Aug. 10, 1909. No. 6993.

Pipe Threads.

Standard Practice in Pipe Threads. J. F. Springer. Considers British and American practice, discussing Great Britain's Whitworth thread and the American Briggs thread. 4000 w. Power—Aug. 3, 1909. No. 6820.

Shafts.

The Calculation of Vibration and Whirling Speeds. Arthur Morley. A Mathematical article indicating extension of results obtained to the more complex cases which occur in practice. 2000 w. Engng—July 30, 1909. Serial, 1st part. No. 6984 A.

Springs.

A Graphical Logarithmic Chart for the Design of Springs (Logarithmischzeichnerische Tafel zur Federberechnung). Victor Fischer. Explains the construction and use of the chart. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7469 D.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

Some Notes on Making Aluminum Castings in Green Sand Molds. Directions for the aluminum mixture, melting, molding, etc. 2500 w. Brass Wld—Aug., 1909. No. 7135.

Brass Founding.

Ornamental Brass Register Parts. Illustrates and describes methods of National Cash Register Co. in producing ornamental brass castings. 3000 w. Foundry—Aug., 1909. No. 6812.

The "Burning" of Copper During Melting and Its Effect on Castings. Explains the right method and the care needed. Ills. 700 w. Brass Wld—Aug., 1909. No. 7136.

Castings.

Thin Cores in Metal Casting. Walter J. May. Suggestions for cases where thin cores are desirable. 600 w. Prac Engr—Aug. 13, 1909. No. 7318 A.

The Production of Steam Cylinder Castings. Herbert M. Ramp. Discusses some of the essentials of materials and workmanship to produce successful castings. 2500 w. Foundry—Aug., 1909. No. 6815.

Molding and Casting of Radiators (Formen und Giessen von Radiatoren und Rippenheizkörpern in der Zentralheizung). Franz Kerth. A description of modern practice. Ills. Serial, 1st part. 2300 w. Giesserei-Zeit—July 15, 1909. No. 7266 D.

Cupola Practice.

Bringing Down Iron Soft in the Cupola. Walter J. May. Suggestions for the manipulation of the cupola and related matters. 1200 w. Mech Wld—Aug. 13, 1909.—No. 7320 A.

Cupola Air Pressure. Walter J. May. Suggestions for supplying large volumes of air at low pressure over the whole charge. 1400 w. Prac Engr—July 23, 1909. No. 6841 A.

Cutting Metals.

Metal-Cutting by Means of Oxygen. Describes this process, illustrating apparatus used and work accomplished. 2200 w. Engng—Aug. 6, 1909. No. 7103 A.

Foundries.

The Foundry Plant of the Sulzer Brothers in Winterthur (Die Giessereianlagen der Maschinenfabrik Gebrüder Sulzer in Winterthur). Illustrated de-

tailed description of this large works. 3000 w. Stahl u Eisen—July 7, 1909. No. 7257 D.

Foundry Management.

See Cost Systems, under INDUSTRIAL ECONOMY.

Foundry Practice.

The Principles of Iron-Foundry: Some Things a Foundryman Should Know. Prof. Humboldt Sexton. The present article deals with the properties of pig iron and how they are modified by various constituents and treatment. Ills. 2500 w. Prac Engr—July 23, 1909. Serial, 1st part. No. 6839 A.

The Application of "Rule of Thumb" and Science in the Iron Foundry. Sidney G. Smith. Read before the British Found. Assn. A discussion of foundry methods. 4500 w. Mech Engr—Aug. 6, 1909. No. 7094 A.

Foundry Practice (Aus der Eisen- und Stahlgiessereipraxis). L. Treuheit. An abstract of a paper giving results of observations and experiments on molding sand, cupola practice and the production of steel castings. Ills. Serial, 1st part. 4300 w. Stahl u Eisen—July 7, 1909. No. 7258 D.

Furnaces.

Electrical Conditioning Oven. Henry S. Ellis. Illustrates and describes details of an apparatus for ascertaining the percentage of moisture in any fabric. 1000 w. Elec Engr, Lond—Aug. 6, 1909. No. 7088 A.

The Use of Gas for Heating. Illustrates and describes some appliances used in hardening and tempering. 5000 w. Ind Engng—Aug. 15, 1909. No. 7179 C.

The Regenerative Furnace in the Forging Shop (Der Regenerativofen als Schmiedofen). Ernst H. Steck. Describes the furnace and discusses its applicability to this class of work. Ills. 2700 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7468 D.

Hydraulic Tools.

Watson-Stillman Hydraulic Shears. Illustrated description of a new beam shear and a coping machine. 1200 w. Ir Age—Aug. 19, 1909. No. 7132.

Inoxidation Processes.

Inoxidation Processes for Protection of Iron and Steel. Alfred Sang. Brief reviews of the various processes. 2500 w. Elec-Chem & Met Ind—Aug., 1909. No. 6826 C.

Jigs.

Jig for Drilling Grate Arms. C. E. Lester. Brief illustrated description. 400 w. Boiler Maker—Aug., 1909. No. 6929.

Machine Tools.

The Ernst Schiess Works, Düsseldorf. Illustrates and describes some products of these machine-tool works. 1200 w. Engng—Aug. 6, 1909. Serial, 1st part. No. 7105 A.

Horizontal Boring, Drilling, Tapping, Studding, and Milling Machine. Illustrated detailed description of a machine built for an engineering firm in Glasgow. 1200 w. Engr, Lond—Aug. 13, 1909. No. 7332 A.

Moldings.

Large Flywheels Floor-Molded. Presents the advantages of this practice as compared with pit molding. Ills. 1200 w. Foundry—Aug., 1909. No. 6813.

Three Methods of Molding Pump Plungers. J. Temple McCartney. A brief résumé of the methods employed at the Drifton shops of the Lehigh Valley Coal Co. Ills. 1200 w. Foundry—Aug., 1909. No. 6816.

Molding Machines.

The Mumford High-Trunnion Squeezer Molding-Machine. Illustrations, with brief description. 800 w. Engng—July 23, 1909. No. 6849 A.

Molding Sand.

Modern Machinery and Methods for the Preparation of Molding Sand (Neuzeitliche Formsandaufbereitung und ihre Maschinen). R. Lüssenhop and Mögling. Describes particularly automatic machinery. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—July 31, 1909. No. 7480 D.

Pipe Threading.

Modern Machines for Pipe Threading. J. F. Springer. Illustrates and describes examples of modern pipe-threading machines. 4500 w. Power—Aug. 17, 1909. No. 7112.

Pneumatic Tools.

The Operation of Pneumatic Tools (Etude sur le Régime de Fonctionnement d'une Installation d'Outillage actionné par l'Air comprimé). A. van Aerde. A mathematical and graphical consideration of air consumption and the time of doing specified work under stated conditions of pressure. Ills. 3000 w. All Indus—June, 1909. No. 7225 D.

Shop Appliances.

Some Typewriter Shop Tools. J. P. Quinn. Illustrates and describes devices used in typewriter manufacture. 1500 w. Am Mach—Vol. 32. No. 34. No. 7345.

A Twenty-five Dollar Tool-Making Job. H. J. Bachmann. Gives in detail the money spent on an extensive spindle for a drill press, and the benefits derived from its use. 1200 w. Mach, N Y—Aug., 1909. No. 6811 C.

Shop Construction.

See Shop Design, under MACHINE WORKS AND FOUNDRIES.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. A systematic study from preliminary service to occupancy. 4500 w. Engineering Magazine—Sept., 1909. Serial, 1st part. No. 7414 B.

The Design of Industrial Works. George H. Gibson and A. Home-Morton.

We supply copies of these articles. See page 156.

Abstract of paper read before the Glasgow Tech. Col. Sci. Soc. The factors and requirements deserving consideration to secure a well-designed and well-equipped works, with discussion of details. 3500 w. Mech Engr—July 30, 1909. No. 6972 A.

Shop Practice.

Laying Out Work. Gives examples of the laying out of machine parts, with illustrations from various kinds of work. 1000 w. Mach, N Y—Aug., 1909. Serial, 1st part. No. 6810 C.

Operations in Building and Inspecting Lathes. Illustrates and describes the methods of the Hendey Machine Co., Torrington, Conn. 3000 w. Am Mach—Vol. 32. No. 31. No. 6895.

Electric Lamps in the Making. Frederick Blount Warren. Illustrated description of methods used in a Philadelphia plant. 1500 w. Sci Am—Aug. 7, 1909. No. 6958.

Details of Watt-Hour Meter Manufacture. Joseph B. Baker. Illustrated description of features of interest in this work. 3500 w. Elec Rev, N Y—Aug. 14, 1909. Serial, 1st part. No. 7066.

See also Locomotive Repairs, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shops.

The Mesta Machine Company's Plant. Illustrated detailed description of an immense plant at West Homestead, Pa., producing engines, rolling mill machinery, steel castings, etc. 3000 w. Ir Age —Aug. 12, 1909. No. 6999.

Welding.

Autogenous Welding. C. B. Auel. Specially describes the use of the oxy-acetylene process. Ills. 5400 w. Elec Jour—Aug., 1909. No. 7025.

Welding Metals with Electricity. E. F. Lake. Illustrates and describes machines used, the methods and advantages. 4000 w. Am Mach—Vol. 32. No. 31. No. 6896.

Woodworking Machines.

The Carstens Cylindrical Shaft on Planers (Dégauchisseuse et Arbre roud de Sûreté "Carstens"). Discusses the efficiency of the Carstens shaft in preventing accidents. Ills. 3500 w. Rev Indus—July 17, 1909. No. 7226 D.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Importance of Vanadium in the Iron and Steel Industry (Das Vanadium und seine Bedeutung für die Eisen- und Stahlindustrie). A. Haenig. An exhaustive discussion of vanadium ores, mining, metallurgy and alloys. Serial, 1st part. 2800 w. Zeitschr d Mitt Motorwagen Ver—July 31, 1909. No. 7292 D.

Bearing Metals.

Bearing Metal. Joseph H. Hart. Considers the qualities of a good bearing metal, their composition, and matters related. 2000 w. Mach, N Y—Aug., 1909. No. 6805 C.

Bronzes.

On the Magnetic Properties of Certain Copper Alloys. A. D. Ross and R. C. Gray. Gives a report of research work on aluminium and manganese bronzes and on the constituent metallic elements. 1500 w. Elect'n, Lond—Aug. 6, 1909. No. 7092 A.

Cast Iron.

Twenty-Five Years of Cast Iron. Prof. Thomas Turner. Abstract of paper read before the British Found. Assn. A summary of work done in Birmingham, Eng., during the last quarter-century. 5500 w. Mech Wld—Aug. 13, 1909. No. 7323 A.

Influence of Chemical-Compounds on the Properties of Cast Iron. A. H. Hiorns. Read before the British Found. Assn. Considers the influence of the usual elements found in cast iron. 3500 w. Mech Engr—Aug 6, 1909. No. 7095 A.

Effect of Permanent Molds on Iron. Edgar Allen Custer. Read before the Am. Soc. for Test. Mat. An illustrated discussion of the peculiar properties imparted to cast iron by the use of permanent molds. 2000 w. Foundry—Aug., 1909. No. 6817.

Metallography.

The Structure of Steels at High Temperatures (Sur la Structure des Aciers aux Températures élevées). M. A. Baykoff. Results of experiments to determine the nature of austenite. Ills. 1000 w. Rev de Métal.—July, 1909. No. 7200 E + F.

Packings.

Metallic Packings. Describes some of the best known packings of this type, illustrating their general features. 2000 w. Prac Engr—July 30, 1909. Serial, 1st part. No. 6967 A.

Steel.

Sparks as an Indication of the Quality of Steel (Die Funken als Erkennungszeichen der Stahlsorten). Discussion and criticism of M. Bermann's paper in the *Zeitschrift des Vereines Deutscher Ingenieure* for January 30, 1909. Ills. 4500 w. Stahl u Eisen—July 21, 1909. No. 7262 D.

Tool Steels.

Tool Steel Specifications for the United States Navy. Gives the reports submitted by the Board on tool steel, dealing with the qualities, shapes, sizes, different brands, and reasons in each case. 6000 w. Iron Age—Aug. 12, 1909. No. 7001.

Buying Carbon Tool Steel on Specification. J. M. Darke, in *Gen. Elec. Rev.* Gives the specifications drawn, and explains the advantages. 1500 w. Ir Age —Aug. 12, 1909. No. 7002.

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MEASUREMENT.

Dynamometers.

See Locomotive Dynamometers, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Gauges.

Limit Gauge Bolts (Ueber Grenzlehrbolzen). August Bauschlicher. Describes various types. Ills. 2000 w. Zeitschr f Werkzeug—July 25, 1909. No. 7450 D.

Gear Testing.

See same title, under AUTOMOBILES.

Hardness.

A Metal Dynamograph and Results. W. A. Knight. Illustrated description of an apparatus for determining the hardness of different materials used in machine-shop practice. 2500 w. Am Mach—Vol. 32. No. 34. No. 7344.

Influence of the Scleroscope in Metallurgy and Manufacturing. A. F. Shore. Illustrated description of the instrument and some of its applications. 3000 w. Mach, N Y—Aug., 1909. No. 6806 C.

Impact.

Calculation of the Resistance to Shock of Certain Test Pieces (Calcul du Travail de Choc que peuvent Supporter quelques Eprouvettes). L. Grenet. Mathematical discussion of the resistance to shock of bars of various shapes and variously supported. Ills. 2800 w. Rev de Métal—July, 1909. No. 7201 E + F.

Pyrometry.

See same title, under MINING AND METALLURGY, COPPER.

Testing Machines.

A Fatigue Testing Machine. J. H. Smith. Illustrated description of a machine designed by the writer, with explanation of the difficulties overcome. 3500 w. Engng—July 23, 1909. No. 6847 A.

Testing Methods.

Commercial Testing of Iron and Steel. W. F. Burrow. Abstracted from a report to the N. S. W. Government. Describes methods used at the Government testing works at Lithgow, Australia. 3500 w. Ir & Coal Trds Rev—July 30, 1909. Serial, 1st part. No. 6991 A.

Observation of the Damping of Vibratory Movements as a Test for Metals (Intervention de l'Amortissement dans l'Essais des Fers; Sur l'Essai des Métaux par Amortissement des Mouvements vibratoires). Two papers by A. Guillet and Henry Le Chatelier. 2500 w. Rev de Métal—July, 1909. No. 7203 E + F.

POWER AND TRANSMISSION.

Air Compression.

Volumes, Pressures and Temperatures in the Adiabatic Compression of Air. Frank Richards. Gives table and chart showing relations of ratios, with explanations. 2500 w. Am Mach—Vol. 32. No. 34. No. 7347.

Air Compressors.

Air Compressors. The present article considers briefly the compression of air, and air compressor diagrams. 600 w. Prac Engr—July 23, 1909. Serial, 1st part. No. 6842 A.

Compressed Air Production and Use. A. C. Whittome. Read before the transvaal Inst. of Mech. Engrs. Explains an easy and comparatively accurate method of comparing the efficiency of various types of compressors. Discusses reheating, causes of explosions, etc. 3500 w. Ir & Coal Trds Rev—July 23, 1909. No. 6860 A.

Two-Stage Air Compression. George L. Fales. Illustrated account of the conversion of a single-stage compressor into a two-stage machine. 1000 w. Power—Aug. 31, 1909. No. 7409.

Compressed Air.

Advantages and Disadvantages of Compressed Air Power Transmission on Contract Work as Compared with Steam. Extracts from an article by Frank Richards in "Barge Canal Bulletin" for July, 1909. Claims a saving in cost and explains numerous advantages. 2500 w. Engng-Con—Aug. 11, 1909. No. 7006.

Air Receiver Practice. Frank Richards. Discusses the desirability of having dry compressed air, and the efforts of recent practice to obtain it. Ills. 2000 w. Power—Aug. 24, 1909. No. 7337.

Electric Driving.

The Application of Electric Motors to Industrial Service. E. B. Parsons. Read at Westinghouse Motor Dealers' Convention. Considers the development and progress, and the field for direct- and alternating-current motors. 2500 w. Elec Engr, Lond—Aug. 13, 1909. No. 7199 A.

The Electrical Operation of Textile Factories. Herbert W. Wilson. Reviews recent developments in this application of electricity, showing some of the points requiring attention. 2500 w. Inst of Mech Engrs—July, 1909. No. 6973 N.

Gearing.

Power Transmission by Toothed Wheels (Sulle Trasmissioni per Ruote dentate). Ottorino Pomini. Begins a complete discussion of power transmission by gearing, with a consideration of the design of gear wheels. Serial, 1st part. 3300 w. Industria—July 18, 1909. No. 7242 D.

Lubrication.

The Selection of an Oil for Lubrication. Henry M. Wells and William Scott-Taggart. Notes on the use of oil testers, emulsification, and evaporation of oils, deposits, etc. 3500 w. Power—Aug. 3, 1909. No. 6821.

Mechanical Plants.

The Mountain Residence, at Arden, N. Y., of Mr. E. H. Harriman. Lucy

Cleveland. Describes especially the plant for heating, lighting and water supply, of this fine 69-room residence, with its 13 halls and 30 bath-rooms. Ills. 4500 w. Dom Engng—Aug. 21, 1909. No. 7188.

The Mechanical Plant of the Harvard Medical School. Howard S. Knowlton. Plans and detailed description of a plant for the dual work of instruction and research. It serves a group of buildings. 4000 w. Eng Rec—July 31, 1909. Serial, 1st part. No. 6797.

The Mechanical Plant of the Hotel Denechaud, New Orleans. Howard S. Knowlton. Plan and detailed description of a plant for supplying electric light, power, refrigeration, hot and cold water and steam-heating service. 2000 w. Eng Rec—Aug. 28, 1909. No. 7385.

Rehabilitating Mechanical Equipment of a New York Hotel. George T. Mott. Illustrated description of the modernized plant recently installed in the Albermarle Hotel. 2000 w. Met Work—Aug. 28, 1909. No. 7404.

Power Plants.

New Power Plant at Williamsport, Penn. Illustrated description of a modern plant having novel layout of steam and feed-water piping, and interesting coal-handling apparatus and condenser arrangement. 1500 w. Power—Aug. 10, 1909. No. 6992.

STEAM ENGINEERING.

Boiler Design.

The Development of a Boiler Horsepower. William Kent. An analysis of the number of square feet of heating surface necessary to develop one horsepower. 2500 w. Ind Engng—Aug. 15, 1909. No. 7178 C.

Boiler Efficiency.

The Economical Production of Steam (Etude sur la Production économique de la Vapeur). M. Izart. The first part of a serial dealing exhaustively with all the factors influencing boiler economy. Efficiency of heat transmission is here considered. Ills. Serial, 1st part. 9500 w. Rev de Mécan—July, 1909. No. 7203 E + F.

Boiler Fittings.

Practical Points on the Water Column. J. R. Early. Advice about their location and care. 4000 w. Power—Aug. 24, 1909. No. 7339.

A Study of the Boiler Blowoff. J. C. William Greth. Considers its function and efficiency. 4000 w. Power—Aug. 31, 1909. No. 7411.

Boiler Management.

How Boilers are Ruined. William Olsen. Discusses the troubles due to scale and corrosion, and the best method of preventing such troubles. 1200 w. Boiler Maker—Aug., 1909. No. 6927.

Boiler Repairs.

Putting a Half Sheet on the Bottom of a 66-Inch by 16-Foot Horizontal Tubular Boiler. Henry Mellon. Illustrated detailed description. 2000 w. Boiler Maker—Aug., 1909. No. 6926.

How to Re-tube a Horizontal Tubular Boiler. Henry Mellon. Detailed description. 1000 w. Boiler Maker—Aug., 1909. No. 6928.

Boilers.

The Erie City Vertical Water-Tube Boiler. Illustrated description of details of construction, circulation, etc. 1500 w. Ir Age—Aug. 19, 1909. No. 7133.

Boiler Settings.

Steam Boilers and Brickwork. Suggestions for the setting of boilers, with a statement of the advantages of the Poulton setting. 2000 w. Col Guard—July 23, 1909. No. 6846 A.

Boiler Testing.

Notes on the Theory of Boiler Testing and Calculations Relating to the Same. Gives a practical example of the calculation of the stresses and factors of safety, introductory to a consideration of the thermal side of boiler testing. 2500 w. Prac Engr—Aug. 13, 1909. Serial, 1st part. No. 7317 A.

Boiler-Water Meters.

See Condenser Meters, under STEAM ENGINEERING.

Condenser Meters.

The "Lea" Water-Recorder. Illustrated description of a new apparatus and its operation. 1700 w. Engng—Aug. 13, 1909. No. 7326 A.

The Lea Continuous Engine Recorder. William H. Booth. Illustrated description of an English device to record water rate of engines, and other uses. 3000 w. Power—Aug. 31, 1909. No. 7413.

Condensers.

The Relationship Between Condenser and Air Pump. R. M. Neilson. Considers partial pressures, factors influencing the transmission of heat from the steam to the condensing water, the air-pump's influence on the condenser, and condenser's influence on the air-pump. 4500 w. Engr, Lond—Aug. 6, 1909. No. 7107 A.

Determining the Amount of Injection Water Required to Condense Exhaust Steam. A. W. Empson. Gives chemical method of ascertaining the ratio between injection water and steam. 1200 w. Elec Rev, Lond—Aug. 6, 1909. No. 7089 A.

A Novel Condenser Design. Edwin Yawger. From a paper before the Assn. of Ir. & St. Elec. Engrs. Illustrates and describes the Leblanc condenser. 1700 w. Eng News—Aug. 19, 1909. No. 7143.

The Westinghouse-Leblanc Condenser. Edwin Yawger. From an address before the Assn. of Ir. & St. Elec. Engrs. Illustrates and describes the essential features and gives information regarding their use. 2500 w. Ir Age—Aug. 5, 1909. No. 6890.

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Westinghouse-Leblanc Condenser at the Lambrecht Pit of the Anzin Mines (La Condensation par Mélange système Westinghouse-Leblanc, à la Fosse Lambrecht, des Mines d'Anzin). Ch. Dantin. Describes a large installation. Ills. 3000 w. Génie Civil—July 17, 1909. No. 7231 D.

Engine Capacity.

Charts to Determine Engine and Generator Capacities in Direct Connected Units. N. A. Carle. Gives charts, and illustrates their use by examples. 600 w. Power—Aug. 24, 1909. No. 7336.

Engine Design.

The Ideal Piston Pin. Horace L. Arnold. Aims to show that a very large diameter, soft-steel piston pin can be placed without trouble, and that fixing the piston pin in the rod end is better in every way than fixing the pin in the piston bosses. Ills. 1200 w. Am Mach—Vol. 32. No. 34. No. 7348.

Engines.

The Growth of the High Speed Engine. Extract from a paper by Prof. John E. Sweet, read before the Modern Science Club, Brooklyn, N. Y. Ills. 2200 w. Am. Mach—Vol. 32. No. 33. No. 7165.

A High-Speed Corliss Engine. Samuel S. Webber. Gives the history of an engine built in the years 1876-1877. Ills. 1200 w. Cassier's Mag—Aug.. 1909. No. 7039 B.

Flue-Gas Analyses.

Simplified Results From Flue Gas Analyses. Frank Kingsley. Gives a formula based on the percentage of nitrogen to establish the percentage of excess air, with explanation and diagrams illustrating their use. 1800 w. Eng Rec—Aug. 21, 1909. No. 7308.

Fuels.

See Shrinkage, under MINING AND METALLURGY, COAL AND COKE.

Oil Separators.

Elimination of Oil from Condensed Steam. George H. Gibson. Discusses methods of removal. 1500 w. Power—Aug. 24, 1909. No. 7338.

Steam Generation.

The Law of Mixed Vapors Applied to the Steam Plant. W. H. Booth. Explains why the law does not always hold good. 2500 w. Power—Aug. 10, 1909. No. 6994.

Steam Loop.

The Inception of the Steam Loop. James H. Blessing. Describes this device and its operation. 1500 w. Power—Aug. 31, 1909. No. 7412.

Steam Pipes.

Leaky Steam Pipe Joints and What Causes Them. William F. Fischer. Faults due to poor design of the piping system are discussed, and other causes and remedies. 1500 w. Power—Aug. 10, 1909. No. 6996.

Steam Properties.

Formulae Connecting the Pressure and Temperature of Saturated Steam. S. Godbeer. Reviews briefly the data available, and develops a new formula. 1500 w. Engng—Aug. 6, 1909. No. 7102 A.

The Solution of Steam Problems by the Use of a Diagram. Lionel D. Marks. Gives a diagram of total heat entropy, showing pressures, qualities and specific volumes, with explanations and solutions of problems. 5000 w. Eng News—Aug. 26, 1909. No. 7358.

Superheating.

Superheated Steam. James A. Seager. Considers the advantages and disadvantages of superheating, and the three systems most used. 2800 w. Cent Sta—Aug., 1909. No. 6997.

Turbine Design.

The Design of Thrust Bearings for Horizontal and Vertical Turbine Machinery (Kammlagerkonstruktionen sowie deren Berechnung bei Turbomaschinen mit Horizontaler und vertikaler Welle). Emil Gutmann. Describes types and discusses the principles of design. Ills. 2700 w. Die Turbine—July 5, 1909. No. 7287 D.

Turbine Losses.

The Internal Losses of a Steam Turbine. A. G. Christie. Review and analysis of tests made in England, with a view to determining where losses occur and their nature. Ills. 3500 w. Power—Aug. 24, 1909. No. 7335.

Turbine Regulation.

Steam-Turbine Regulation and its Influence on the Power Output of the Individual Pressure Stages (Die Regelung von Dampfturbinen und ihr Einfluss auf die Leistungsentwicklung in den einzelnen Druckstufen). Herbert Baer. Considers the effect of various methods of regulation. Ills. Serial, 1st part, 3500 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7466 D.

Turbines.

Steam and Gas Turbines (Les Turbines à Vapeur et les Turbines à Gaz). Paul Razous. A discussion of their mechanical and thermodynamic features. 3500 w. Rev d'Econ Indus—July 16, 1909. No. 7204 D.

5,000-KW Exhaust-Steam Turbine in Interborough Powerhouse. Plan and description of the Curtis exhaust-steam turbine recently placed in the 59th Street station, in New York City. 800 w. Elec Wld—Aug. 12, 1909. No. 7012.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Recent Progress in the Construction of Aerial Tramways (Recenti Progressi sulla Costruzione di Ferrovie Aeree). Describes a number of recent installations. Ills. Serial, 1st part. 2000 w. Ing Ferro—July 1, 1909. No. 7247 D.

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Cableways.

The World's Most Remarkable Aerial Tramway. Abstract translation from *Zeit. des Ver. Deut. Ing.* Illustrated detailed description of a line in Argentine Republic. It is 22 miles long and has a total ascent of 11,800 feet. 5500 w. Ind Engng—Aug. 15, 1909. No. 7176 C.

Cableways (Les Transports aériens sur Cables). P. Pièrart. Describes the construction of various systems, uses of aerial tramways and notable examples. Ills. Serial, 1st part. 3500 w. All Indus—July 1909. No. 7224 D.

Car Dumping.

Unloading Railroad Cars by Machinery. Snowden B. Redfield. Illustrated description of the McMyler car dumper at the Hoboken docks of the D., L. & W. R. R. Co., and its operation. 2200 w. Am Mach—Vol. 32. No. 33. No. 7163.

Coal Handling.

Bulk Handling of Coal at the Anhalt Mines (Massenbeförderung von Kohle auf den Gruben der Anhaltischen Kohlenwerke). E. Ullmann. Illustrates and describes bins, cars, electric locomotives, etc. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—July 17, 1909. No. 7473 D.

Conveyors.

Belt Conveyors for Handling Materials. George Frederick Zimmer. Illustrates and describes this method of handling and distributing materials. 3000 w. Cassier's Mag—Aug., 1909. No. 7037 B.

Labor Saving Devices in Industries. G. A. Julius. Abstract of paper read before the Engng Assn. of N. S. W. A review of ancient and modern appliances for the handling and transport of materials. 3000 w. Aust Min Stand—June 16, & 23, 1909. Serial, 2 parts. No. 6862 each B.

Cranes.

Revolving Cantilever Crane Built by the Benrath Machine Co. (Turmdrehkran, gebaut von der Benrather Maschinenfabrik A.-G.). F. Heym. Illustrated description of a large crane recently installed in St. Nazaire harbor. 1600 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7475 D.

Elevators.

Belted Electric Elevators. William Baxter, Jr. Describes the principal methods of operation and some features of construction. Ills. 2500 w. Power—Aug. 17, 1909. No. 7111.

Lifting Magnets.

Electric Lift Magnets. Lawrence Whittridge Cady. Brief discussion of their uses, care needed and related subjects. 1000 w. Elec Wld—Aug. 5, 1909. No. 6903.

Pulley Blocks.

See Erection, under CIVIL ENGINEERING, BRIDGES.

Rotary Conveyors.

A Novel Type of Rotary Conveyor. Illustrated description of a type of transporter devised by an English engineer, A. R. Grossmith, for carrying top soil from the excavation site to the dump. 1500 w. Sci Am—Aug. 7, 1909. No. 6959.

MISCELLANY.

Aeronautics.

A Note on the Theory of the Aeroplane (Breitrag zur Theorie der Drachenflieger). A. Jarolimek. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver —July 30, 1909. No. 7453 D.

A Criticism of the Aeroplane (Kritik der Drachenflieger). Ansbert Vorreiter. A criticism of various principles and details of construction of the existing machines. Ills. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—July 10, 1909. No. 7471 D.

The Commercial Airship. C. A. McReady. Analyzes the principles of heavier-than-air, and lighter-than-air, machines, and explains the vacuum airship and its advantages. 1800 w. Mach, N Y—Aug., 1909. No. 6809 C.

Progress in Airship Construction (Fortschritte im Luftschiffbau). Dr. Wagner. Discusses principles of design and describes several types. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7478 D.

Report on the Award of the Osiris Prize in 1909 (Rapport sur le Prix Osiris à Décerner en 1909). Emile Picard. Reviews the reasons for the choice this year of aviation and the basis of the joint award of this prize of the Institute of France to Voisin and Blériot. 4000 w. Rev Gen des Sciences—July 15, 1909. No. 7218 D.

Orville Wright's Record Flights at Fort Myer. A report of the government contract tests. Ills. 1000 w. Sci Am—Aug. 7, 1909. No. 6957.

A Comparison of American Aeroplanes. Augustus Post. Compares the construction and control of the Curtiss and Wright machines. 3500 w. Am Mach—Vol. 32, No. 33. No. 7164.

The United States Signal Corps Aeroplane. Illustrated description of the Wright Machine that met the specifications by carrying two men for an hour's flight and making a speed of 42½ miles per hour. 3000 w. Am Mach—Vol. 32, No. 32. No. 7010.

M. Louis Blériot and His Aeroplanes. Illustrated descriptions of the latest successful monoplanes of this French engineer. 1200 w. Sci Am Sup—Aug. 28, 1909. No. 7381.

The Blériot Monoplane That Flew the Channel. Illustrated description. 2500 w. Am Mach—Vol. 32, No. 31. No. 7349.

The Crossing of the English Channel by M. Blériot (La Traversé de la Manche en

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Aéroplane par M. Blériot, avec son Monoplan No. XI, 25 Juillet 1909). Describes the aeroplane and gives details of the flight. Ills. 5500 w. Génie Civil—July 31, 1909. No. 7234 D.

The Cross-Channel Flight. An illustrated account of the feat accomplished by M. Blériot, with description of the aeroplane used. 1000 w. Engr, Lond—July 30, 1909. No. 6989 A.

The Channel Flight. Editorial on the feat of M. Blériot in crossing the English Channel in an aeroplane. 1500 w. Engng—July 30, 1909. No. 6986 A.

Guns.

The Life and Power of Heavy Ordnance. Editorial review of recent articles dealing with this subject, and a comparison of British and German guns. 2500 w. Engng—July 23, 1909. No. 6852 A.

Textile Machinery.

Analysis of Power Distribution in a Cotton Spinning Frame. Albert Walton. An illustrated article discussing in detail a chart obtained in a testing set with electric driving. 3000 w. Cassier's Mag—Aug., 1909. No. 7038 B.

Weighing Machines.

A Weighing Machine with Automatic Slide (Le Systéme de Bascule à Curseur automatique). Leon Masson. Detailed description of a scale in which the slide is automatically operated by clock work, which also operates indicating and recording devices. Ills. 2500 w. Bul Soc d'Encour—June, 1909. No. 7216 G.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

The Prevention of Accidents in Coal Mines. E. H. Coxe. Considers proper supervision and organization of great value, and that the danger is lessened by using permissible explosives and efficient spraying. 4000 w. Eng & Min Jour—Aug. 28, 1909. No. 7391.

Alaska.

The Coal Resources of Southwestern Alaska. W. W. Atwood. Extract from Bul. 379, U. S. Geol. Surv. Map and a brief summary of the coal resources of Alaska and adjacent islands. 3500 w. Min Wld—Aug. 28, 1909. No. 7393.

Australia.

Mercury, Copper and Coal Mines, Little River, Cook District. Lionel C. Ball. Describes the geology, occurrence, workings, and states conclusions. 5500 w. Queens Gov Min Jour—June 15, 1909. No. 6861 B.

Briquetting.

See Locomotive Fuel, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Canada.

Reciprocity in Coal—A Western Point of View. E. Jacobs. A summary of coal mining and production in Canada, and discussing the subject of reciprocal arrangements for free coal. Map. 7000 w. Can Min Jour—Aug. 1, 1909. No. 6878.

Coal Cutting.

The Disc Electric Coal-Cutting Machine. Sidney F. Walker. Illustrated detailed description of the machine and its operation. 1500 w. Mech Wld—July 23, 1909. Serial, 1st part. No. 6843 A.

The Employment of Coal-Cutting Machines in the Ruhr District, Germany (Zur Frage der Verwendung der Schrämmaschine im Ruhrkohlenbergbau). Ernst Jüngst. A critical examination of their economy. 5400 w. Glückauf—July 3, 1909. No. 7272 D.

Coking Plant.

The Greatest Bakery in the World. George Frederic Stratton. Illustrated description of coke-making in the Connellsville region. 2200 w. Am Mach—Vol 32. No. 31. No. 6897.

Electric Power.

Electricity in Mines. George R. Wood. Outlines the ordinary mine development and some of the standard electrical equipment, describing typical coal-mining plants. 4500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7058 F.

Electricity in Coal Mines, New South Wales. A. A. Atkinson and W. Humble. Read before the N Engng Inst, N. S. W. Describes plants, accidents, and precautionary measures necessary. 2500 w. Aust Min Stand—June 23, 1909. Serial, 1st part. No. 6866 B.

Safe Use of Electricity in Mines. George R. Wood. Read before the Coal Min. Inst. of Am. Considers electric coal cutters and dust; shocks from electric wires, and electrolysis. 4000 w. Mines & Min—Aug., 1909. No. 6885 C.

Electric Circuit Problems, Design and Testing. Shows, by worked out examples, how to determine the factors entering into the various problems. 2000 w. Col Guard—Aug. 6, 1909. Serial, 1st part. No. 7100 A.

Colliery Shaft Cables. William Copeland. Considers briefly the kinds of cables used, their troubles and the causes. 1500 w. Elec Engr, Lond—Aug. 13, 1909. No. 7197 A.

England.

Coal Mines Inspection in 1908. Digest of the reports of H. M. inspectors of mines. 55000 w. Col Guard—Aug. 6, 1909 (Sup.). No. 7099 A.

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Explosions.

Notes on Explosive Mine Gases and Dusts, with Special Reference to Explosions in the Monongah, Darr, and Naomi Coal Mines. Rollin Thomas Chamberlin. 25000 w. U. S. Geol Survey—Bul. 383. No. 7016 N.

Dust-Explosions in Coal-Mines. Franklin Bache. Thinks the aim should be to get rid of the dust, and discusses methods. 2500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7127 F.

West Stanley Colliery Explosion. Report of the circumstances attending the explosion that occurred Feb. 16, 1909. Plans. 3300 w. Col Guard—Aug. 13, 1909. Serial, 1st part. No. 7324 A.

The Lievin Testing Station (Description de la Station d'Essais de Liévin). M. J. Taffanel. Illustrated description of a station for investigating problems relating to safety in coal mines. 3200 w. Rev de Métal—July, 1909. No. 7202 E + F.

Kentucky.

The Middlesboro Coalfield in Kentucky. John Howard. A general review of the conditions at the different mines. Ills. 2500 w. Eng & Min Jour—Aug. 14, 1909. No. 7069.

Mine Dust.

French Coal-Dust Experiments. M. J. Taffanel. Abstracted from Pro. of S. W. Inst. of Engrs. Illustrated detailed description of the experimental station. 2000 w. Col Guard—Aug. 6, 1909. Serial, 1st part. No. 7101 A.

The British Coal Dust Experiments. An illustrated account of work at the Experiments Station at Altofts since August, 1908, in connection with the problem of coal-dust explosions. Plate. 4000 w. Col Guard—July 30, 1909. No. 6982 A.

Mine Fires.

Sealing Shafts After Explosion. J. A. Garcia. Describes an attempt to extinguish a mine fire by sealing off the shafts at mine No. 18, Dering Coal Co., Illinois. Ills. 3000 w. Mines & Min—Aug., 1909. No. 6889 C.

Sealing Off Summit Hill Mine Fire. H. H. Stock. Illustrates and describes the sinking of a line of shafts removing coal and rock, and filling space with clay to form a barrier. 3500 w. Mines & Min—Aug., 1909. No. 6880 C.

Mine Gas.

The Influence of Gas on Changes in Mine Air Pressure (Ueber den Einfluss der Bewetterung auf die Spannungsänderungen der Grubenheft). Chr. Mezger. A discussion based on practical observations. Ills. Serial, 1st part. 2700 w. Glückauf—July 31, 1909. No. 7277 D.

Mining Finance.

Coal Mining as an Investment. H. M. Chance. Discusses the elements tending to stability and safety, the causes of failures, etc. 2500 w. Eng & Min Jour—Aug. 14, 1909. No. 7070.

New Guinea.

Geological Features of the Purari River, Western Papua. P. N. Charpentier. Describes recently discovered coal beds. 1500 w. Aust Min Stand—June 30, 1909. No. 6867 B.

Peat.

The Gasification of Peat. Charles A. Davis. Deals with the utilization of low-grade fuels, showing that it is possible to obtain gas for power and heating, high-grade coke, and sufficient by-products to pay the cost of operation. 6000 w. Cassier's Mag—Aug., 1909. No. 7036 B.

Production.

Production of Coal in United States in 1908. E. W. Parker. Summary of statistics of the U. S. Geol. Survey. 4000 w. Min Wld—Aug. 21, 1909. No. 7191.

Prospecting.

Prospecting Anthracite Mines by Drill Holes. Frank Lynde. Describes the systematic methods employed. 3000 w. Eng & Min Jour—Aug. 7, 1909. No. 6943.

Rescue Apparatus.

The Criticism of Portable Breathing Appliances in Dr. Ferdinand Hagemann's Book (Zur Kritik Dr. Ingenieur Ferdinand Hagemanns über die freitragbaren Atmungsapparate in seinem Buche "Bergmännisches Rettungs" und Feuerschutzwesen in der Praxis und im Lichte der Bergpolizeiverordnungen Deutschlands und Oesterreichs). A defense of the portable apaparatus. Serial, 1st part. 1800 w. Oest Zeitschr f Berg- und Hüttenwesen—July 31, 1909. No. 7270 D.

Shrinkage.

Weighing Coal, and Legitimate Shrinkage. From a paper before the Int. Fuel Assn. Considers allowable shrinkage, pilfering, weights and scales. 1500 w. R R Age Gaz—Aug. 20, 1909. No. 7171.

Spontaneous Combustion.

The Spontaneous Heating of Coal. Abstract of a paper by Richard Threlfall giving results obtained by chief investigators of this subject. 2000 w. Ir & Coal Trds Rev—Aug. 13, 1909. No. 7333 A.

Washing.

Coal Washery Plant Control. G. R. Delamater. Gives results of tests with a new float-and-sink machine compared with former tests. Diagrams. 4000 w. Mines & Min—Aug., 1909. No. 6888 C.

Washington.

The Coal Resources of Washington. R. P. Tarr. Describes the geological features and their influence on the quality of coal, extent of development and output. 4500 w. Mines & Min—Aug., 1909. No. 6883 C.

West Virginia.

The Kanawha Region, W. Va. H. H. Stock. Gives information in regard to the location and extent of the region, transportation facilities, output, etc. Ills. 4000 w. Mines & Min—Aug., 1909. No. 6886 C.

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COPPER.

Alaska.

Copper Mining on Prince William Sound, Alaska. U. S. Grant and D. F. Higgins, Jr. Abstract from Bul. 379, U. S. Geol. Survey. Gives brief descriptions of properties being developed. Map. 4500 w. Min Wld—July 31, 1909. No. 6801.

Anode Casting.

Walker Patent Casting Wheel. Illustrated description of the large wheel installed at Port Kemble (N. S. W.) 1200 w. Aust Min Stand—July 7, 1909. No. 7130 B.

Assaying.

A New Volumetric Method for the Determination of Copper (Nuevo Método de Dosaje Volumétrico del Cobre). Juan A. Sánchez. Describes the author's newly devised method. 3000 w. Anales d l Soc Cien Argentina—Jan., 1909. No. 7250 E + F.

Australia.

See same title, under COAL AND COKE.

California.

The Mammoth Mine and Smelter in California. Al. H. Martin. Describes these ore deposits on the west side of the Sacramento River, running from 3 to 12% copper and from $1.50 to $3 in gold and silver, and their treatment. Ills. 1000 w. Min Wld—Aug. 7, 1909. No. 6933.

Copper Mines and Smelteries of Shasta County. George A. Packard. Illustrated description of the Mammoth mine and smelter at Kenneth, Cal., and other adjacent mines. 5500 w. Eng & Min Jour—Aug. 28, 1909. No. 7388.

Germany.

Vein Deposits at Lauterberg in the Harz Mountains (Die Kupfererzgänge bei Lauterberg am Harz). Dr. Fleck. Description of these copper ores. Ills. 4500 w. Glückauf—July 24, 1909. No. 7276 D.

Mexico.

See Caving System, under MINING.

Pyritic Smelting.

Pyritic Smelting by the Knudsen Process in Sulitjelma (Das Pyritschmelzen nach dem Knudsen-Verfahren in Sulitjelma). A review of results of operations in Norway. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 3, 1909. No. 7268 D.

Pyrometry.

The Estimation of the Temperature of Copper by Means of Optical Pyrometers. G. K. Burgess. Describes experiments undertaken to furnish data for approximately correct estimates of the temperature of liquid and solid copper by means of pyrometers. 1800 w. Elec-Chem & Met Ind—Aug., 1909. No. 6823 C.

Smelter Fumes.

The Waste of the Valuable Smelter Fumes. Thomas E. Lambert. Remarks on the effects of fumes, and explanation of a recently patented smoke purifier and fume arrester. 4500 w. Min Wld. July 31, 1909. No. 6800.

Smelter versus Oil Fume. Eugene B. Braden. An account of the complaints made in regard to the fumes from the Selby Smelting & Lead Co.'s plant in California, and the tests made. 2500 w. Min & Sci Pr—Aug. 7, 1909. No. 7044.

Smelting.

Copper Blast Furnace Smelting at Anaconda. C. Offenhaus. Illustrates and describes the types of furnaces used, materials smelted, etc. 5000 w. Eng & Min Jour—Aug. 7, 1909. No. 6941.

Yampa Smelter, Bingham, Utah. Leroy A. Palmer. Describes modern practice for the conversion of crude ore into blister copper. Ills. 3000 w. Min & Sci Pr—Aug. 14, 1909. No. 7158.

GOLD AND SILVER.

Alaska.

Haines District, Alaska. W. A. Scott. Brief account of this gold mining district. 1200 w. Min & Sci Pr—Aug. 7, 1909. No. 7046.

The Fairbanks Gold Placer Region, Alaska. L. M. Prindle and F. J. Katz. Abstracted from Bul. 379, U. S. Geol. Survey. A review of the mining development, and gives information of methods used. Map. 3500 w. Min Wld—Aug. 21, 1909. No. 7190.

Amalgamation.

The Effect on Amalgamation, of Different Intervals of Time Between the Dressings of Plates. G. O. Smart. Gives results of trials. General discussion. 2000 w. Jour Chem, Met, & Min Soc of S Africa—June, 1909. No. 7192 E.

Assaying.

The Assay and Valuation of Gold-Bullion. Frederic P. Dewey. Deals with an effort to establish commercial standards of accuracy in the assaying of gold-bullion for purchase in the various laboratories of the U. S. Mint service. 4500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7125 F.

Bullion Smelting.

The Smelting of Gold Precipitates and Bullion with Oil Fuel. Arthur Yates. Notes on what has been accomplished in Sumatra. 1200 w. Jour Chem, Met, & Min Soc of S Africa—June, 1909. No. 7193 E.

California.

Great Gold Belt in Amador County, California. William H. Storms. An illustrated account of mines on the Mother Lode. 2200 w. Min Wld—July 31, 1909. No. 6799.

Colorado.

See Leasing, under MINING.

Cyaniding.

Modern Cyaniding Practice and Machinery. Arthur Selwyn-Brown. Dis-

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cusses modern methods of grinding and filtration for fast work and large recovery, illustrating and describing machines used. 3500 w. Engineering Magazine—Sept., 1909. No. 7420 B.

See also Air Lift, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Dredging.

Modern Gold Placer Dredging. George B. Massey, 2nd. An Illustrated article considering details necessary to make a dredging enterprise successful, and the important points about the property. 3500 w. Cassier's Mag—Aug., 1909. No. 7032 B.

India.

Ten Years' Review of the Mysore Gold Mine. T. Lington. Reviews the cost, values, profits, etc., of this noted Indian mine. 1000 w. Min Wld—Aug. 14, 1909. No. 7077.

Mexico.

Mining in Oaxaca, Mexico. E. M. Lawton. Explains present conditions and transportation facilities. Ills. 1500 w. Min & Sci Pr—Aug. 14, 1909. No. 7159.

Nicaragua.

Notes on the Nicaraguan Goldfields. M. R. Walker. Sketch map showing location of mines, with details and information. 1200 w. Eng & Min Jour—Aug. 7, 1909. No. 6944.

Placers.

See Alaska, under GOLD AND SILVER.

IRON AND STEEL.

Alabama.

Economic Features of the Birmingham District. John Leggett Pultz. Reviews the features that have been the principal cause of the rapid industrial growth of this district. Ills. 4500 w. Eng & Min Jour—Aug. 14, 1909. No. 7068.

Operating Companies of the Birmingham District. John Leggett Pultz. An account of the furnaces and steel plants of this district, the output and the prospects. Ills. 3500 w. Eng & Min Jour—Aug. 21, 1909. No. 7182.

Blast-Furnace Operation.

Peroxidation of Iron in Blast Furnaces. Antenor Rizo-Patron. Describes the effect of certain pyritic ores when smelted in blast furnaces. 2500 w. Eng & Min Jour—Aug. 21, 1909. No. 7187.

Blast Furnaces.

The Rate of Combustion in Blast Furnaces. M. A. Pavloff. Gives a table showing general conditions of working and rate of combustion of 40 modern furnaces, with remarks. 1800 w. Ir Age—Aug. 26, 1909. No. 7340.

Blowing Engines.

Electrically Operated Blowing Engines for the Converters at the Peine Rolling Mill (Das elektrisch angetriebene Konvertergebläse des Peiner Walzwerks). F. Hartig. Describes the installation and gives results of operation. Ills. 4500 w. Stahl u Eisen—July 14, 1909. No. 7259 D.

Cuba.

The Residual Brown Iron-Ores of Cuba. C. M. Weld. Maps showing locations of deposits and discussion of their character and probable origin. 4000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7128 F.

Desulphurization.

The Formation of Silicon Sulphide in the Desulphurization of Iron. W. Fielding. Read before the Faraday Soc. Describes an investigation made of the reaction between ferrosilicon and ferrous sulphide. 900 w. Elec-Chem & Met Ind—Aug., 1909. No. 6824 C.

Electro-Metallurgy.

The Treatment of Steel in Electric Furnaces. Henry M. Howe. Considers the bearing of the phenomena noted in these furnaces, and general ideas about the purification of iron. Ills. 8000 w. Eng & Min Jour—Aug. 28, 1909. No. 7389.

Ferro-Alloys.

Investigation of Ferro-boron. K. Iwai and J. C. Ballagh. (Prize thesis.) Describes in detail the experiments made, stating conclusions. Ills. 5000 w. Min & Sci Pr—Aug. 7, 1909. No. 7043.

Ferro-Manganese in the Blast Furnace (Ferromangan im Hochofen). O. Höhl. A review of Josef Jakobi's recent experiments on the production of ferro-manganese from manganese ore in the blast furnace. Ills. 1400 w. Stahl u Eisen—July 21, 1909. No. 7263 D.

Georgia.

Review of Fossil Iron Ore Deposits of Georgia. S. Mays Ball. Concerning the characteristics, extent and location of the Clinton ores, and their development. Ills. 4000 w. Eng & Min Jour—July 31, 1909. No. 6788.

Hot-Blast Stoves.

The Design of Hot-Blast Stoves on the Basis of the Heat-Conducting Power of Refractory Materials (Die Berechnung steinerner Winderhitzer unter zugrundelegung des Wärmeleitungsvermögens feuerfester Steine). Bernhard Osann. A complete theoretical treatment. Ills. Serial, 1st part. 2800 w. Stahl u Eisen—July 14, 1909. No. 7260. D.

Illinois.

Extinct Iron Industry in Southern Illinois. Henry E. Birkinbine. An account of deposits formerly developed, which may again prove a source of supply. 2500 w. Ir Tr Rev—Aug. 5, 1909. No. 6913.

New Zealand.

The Parapara Iron-Ore Deposits. Dr. James Mackintosh Bell. Illustrates and describes deposits of great economic value and scientific interest. 4500 w. N Z Mines Rec—May 17, 1909. Serial, 1st part. No. 6963 B.

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Nova Scotia.

Iron Ore Deposits of Nova Scotia. Notes from report by Dr. J. E. Woodman, issued by the Mines Branch, Department of Mines, Ottawa. Map. 800 w. Can Min Jour—Aug. 15, 1909. Serial, 1st part. No. 7161.

Ohio.

Historic Stacks in the Hanging Rock Region. Brief account of stacks at the Olive furnace, Lawrence Co., Ohio. 1000 w. Ir Trd Rev—Aug. 19, 1909. No. 7153.

Open Hearth.

A New Double-Hearth Martin Furnace (Ein neuer Martinofen mit doppeltem Herd). Carl Brisker. Illustrated discussion of the efficiency of the double-hearth type. 2300 w. Stahl u Eisen—July 28, 1909. No. 7264 D.

Russia.

The Iron Works of South Russia (Die Eisenhütten Südrusslands). Z. Bielski. Brief general description of their equipment, etc. Serial, 1st part. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—July 31, 1909. No. 7269 D.

Sheets.

Toncan Metal. F. M. English. Address to Nat. Assn. of Master Sheet Metal Workers. An outline of the characteristics of this metal. 2500 w. Ir Trd Rev—Aug. 19, 1909. No. 7152.

Steel Works.

The Inauguration of Steel-Making on the Pacific Coast. Plan and description of the first plant west of the Rocky Mts., at Seattle, Wash., for making steel bars and shapes. 1200 w. Ir Trd Rev—Aug. 19, 1909. No. 7151.

The Great Steel Works of the Indiana Steel Co. at Gary, Ind. Illustrated detailed description of this large capacity plant and its equipment. 4500 w. Eng News—Aug. 12, 1909. No. 7050.

Tin Plate.

The Manufacture of Roofing Tin. Philip Schaefer. Address before the Nat. Assn. of Master Sheet Met. Workers. Reviews methods from raw materials to finish as practiced in the hammered open hearth tin plate works. 2500 w. Met Work—Aug. 28, 1909. No. 7406.

The Development and Present Condition of the Tin Plate Industry (Ueber die Entwicklung und de gegenwartigen stand der Weissblecherzeugung). Otto Vogel. A technical and commercial review. Ills. 6500 w. Stahl u Eisen—July 21, 1909. No. 7261 D.

MINOR MINERALS.

Antimony.

Antimony in Peru. Eugen Weckwarth. Brief description of the occurrence and associated minerals. 1800 w. Min Jour—Aug. 14, 1909. No. 7319 A.

Asbestos.

Asbestos: Its Occurrence, Production and Uses. J. S. Diller. Abstracted from advance chapter of Mineral Researches of U. S. Deals principally with the deposits of Canada and the United States. 3500 w. Min Wld—Aug. 28, 1909. No. 7395.

Fluorspar.

Barium and Sulphur in Fluorspar. Henry G. Martin, in *Jour of Ind & Engng Chem.* Describes a rapid means of properly valuing this material. Details of a method using the Sundstrom bomb. 1500 w. Ir Age—Aug. 5, 1909. No. 6892.

Fluorspar in Colorado. Ernest F. Burchard. Describes the deposits and their preparation for market, and explains matters relating to this industry. 3000 w. Min & Sci Pr—Aug. 21, 1909. No. 7373.

Marble.

Ancient Marbles Used in Modern Times. Mary W. Porter. Reviews the sources of the ancient stone supply. 2500 w. Sci Am Sup—Aug. 21, 1909. No. 7150.

Mercury.

See Australia, under COAL AND COKE.

Molybdenite.

The Molybdenite Deposits of Tunk Pond, Maine. B. W. Hills. Describes the deposits and the geology of the region. 1500 w. Min Wld—Aug. 7, 1909. No. 6935.

Natural Gas.

Natural Gas. Lee B. Mettler. From a paper before the convention of Kansas Assn. of Master Plumbers. Deals with the pressure of natural gas in Kansas and methods of house piping. 1200 w. Met Work—Aug. 28, 1909. No. 7405.

Oil.

The Los Angeles Oil Industry. Percy E. Barbour. Brief account of these deposits and the history of their development. 1000 w. Eng & Min Jour—Aug. 21, 1909. No. 7186.

Oil-Shales in Scotland. R. Weed. A brief description of the oil-shale works and mines known as the Broxburn and the methods. 1500 w. Ir & Coal Trds Rev—Aug. 6, 1909. No. 7110 A.

Platinum.

A Russian Money Trust. George E. Walsh. An account of the reason why Russia adopted platinum as a metal for money, and why it was discontinued. 1200 w. Min & Sci Pr—Aug. 7, 1909. No. 7045.

Radium.

Radium: Its Occurrence in Australia. S. Radcliff. Explains a simple method of determination. 3500 w. Aust Min Stand—June 23, 1909. No. 6864 B.

Tantalum.

Tantalum and Its Industrial Applications. Alexander Siemens. Read before the Roy. Inst. of Gt. Britain. Reviews the progress of electric lighting, dealing especially with tantalum, its use in this and other fields. 3500 w. Elec Engr, Lond—July 30, 1909. No. 6975 A.

Tin.

Tin Deposits of Southern South Dakota. Frank L. Hess. Abstract from Bul. No.

380, U. S. Geol. Surv. An account of the different claims, describing the deposits. 5000 w. Min Wld—Aug. 28, 1909. No. 7394.

Stanley River Tin Field, Tasmania. Hartwell Conder. Sketch plan and brief description of this field, with which communication has been established. 1200 w. Aust Min Stand—June 16, 1909. No. 6863 B.

MINING.

Caving System.

Cananea Caving and Slicing Systems. R. L. Herrick. Describes the ore-bodies and methods of mining which have resulted in very low costs. Ills. 9800 w. Mines & Min—Aug., 1909. No. 6884 C.

Diamond Drilling.

Diamond Drilling at Tonopah. John M. Fox. Outlines the equipment and labor and describes the progress of the work, costs, etc. 2000 w. Min & Sci Pr—Aug. 21, 1909. No. 7374.

Electric Power.

New A. C. Single-Phase Motors and their Application to Mining Work (Neuere Einphasenwechselstrommotoren und ihre Anwendbarkeit im Bergbau). Herr Spackeler. The first part discusses series motors. Ills. Serial, 1st part. 2700 w. Glückauf—July 17, 1909. No. 7275 D.

Exploration.

The Recovery of an Ore Body or Lost Vein. Arthur Lakes. Describes the mode of procedure and difficulties encountered in such work. Ills. 2000 w. Min Wld—Aug. 21, 1909. No. 7189.

Geological Records.

Recording Geological Data. Thorald F. Field. Explains methods used by the Calumet & Arizona Mining Co. Ills. 1200 w. Mines & Min—Aug., 1909. No. 6882 C.

Haulage.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Hoisting.

Rope Strains in Hoisting. C. W. Beers. Gives a quick method of calculating rope strains in hoisting on any pitch. 600 w. Eng & Min Jour—Aug. 21, 1909. No. 7185.

Stresses and Vibrations in Hoisting Ropes under Variable Acceleration (Seilspannungen und -schwingungen bei Beschleunigungs-änderungen des Schachtförderseiles). A. Stör. Mathematical. Ills. Serial, 1st part. 5000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 3, 1909. No. 7267 D.

Laws.

New Laws Governing Mining in Idaho. Gives the revised laws. 2200 w. Min Wld—Aug. 7, 1909. No. 6934.

Leasing.

Leasing in Cripple Creek District. C. W. Burgess. A thesis submitted at graduation from the Colo. Sch. of Mines. Information regarding the district, with discussion of the advantages of leasing vs. company operation. 7500 w. Mines & Min—Aug., 1909. No. 6881 C.

Mine Signalling.

The Use of Relays in Mining Signalling. An explanation of the Willis system. Diagrams. 1600 w. Prac Engr—July 23, 1909. No. 6840 A.

Prospecting.

See same title, under COAL AND COKE.

Quarrying.

Developments in Quarrying Processes. A. S. Atkinson. Describes modern methods and the application of improved machinery and labor-saving devices. 2500 w. Eng & Min Jour—July 31, 1909. No. 6790.

Shafts.

Concrete Shafts at Lake Iron Mines. Frederick W. Adgate. Read at meeting of Lake Superior Min. Inst. Describes methods used in sinking in quicksand on the Marquette Range. Ills. 3500 w. Ir Age—Aug. 26, 1909. No. 7341.

Shaft Sinking.

Shaft Sinking by the Freezing Process. Sydney F. Walker. Its use in Germany, England and France, the difficulties met and methods of dealing with them. 6500 w. Mines & Min—Aug., 1909. No. 6887 C.

Concrete Linings in Shaft Sinking. R. H. Rowland. Diagrams and description of work in Oklahoma. 1200 w. Eng & Min Jour—Aug. 21, 1909. No. 7184.

Surveying.

Need of Instrumental Surveying in Practical Geology. Benjamin Smith Lyman. On the value of instrumental surveying and mapping. 3000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7123 F.

Timbering.

Some German Mine Props. Illustrates and describes mechanical props, generally made of metal. 1000 w. Eng & Min Jour—Aug. 28, 1909. No. 7392.

Timbering Crushing Seams (Streckensicherung und Entspannungsverheib in druckhaften Flözen). Dr. Niess. Describes timbering methods for galleries in bad ground. Ills. Serial, 1st part. 3100 w. Glückauf—July 3, 1909. No. 7271 D.

Unwatering.

New Unwatering Plant at the Rosenblumendelle Colliery (Die neue Wasserhaltungsanlage der Zeche Rosenblumendelle). Herr Eichler. Describes the arrangement of sumps and the electric pumping plant. Ills. 2000 w. Glückauf—July 17, 1909. No. 7274 D.

ORE DRESSSING AND CONCENTRATION.

Crushers.

The New Cochran Crusher. J. T. Barkelew. Describes a crusher having a new movement combining crushing and torsional effect. 1200 w. Eng & Min Jour—Aug. 7, 1909. No. 6945.

Elmore Process.

Elmore Process as Applied by Zinc Corporation. Illustrated description of works

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in New South Wales, and of methods of treatment. 1500 w. Eng & Min Jour—July 31, 1909. No. 6789.

Sampling.

Modern Practice of Ore-Sampling. David W. Brunton. Reviews methods of sampling used in the past and present, illustrating and describing types of time-samplers and other sampling machines. 5500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7124 F.

Silver Milling.

All-Sliming. E. M. Hamilton. Discusses the advisability of all-sliming in the cyanidation of silver ores, describing an appliance for collecting clean charges of extremely fine sand. 2000 w. Min & Sci Pr—Aug. 21, 1909. No. 7372.

MISCELLANY.

Charcoal Furnaces.

A Typical Hanging Rock Charcoal Furnace. An account of the ten-ton Jefferson furnace at Oak Hill, O. Ills. 2500 w. Ir Trd Rev—Aug. 5, 1909. No. 6914.

Colombia.

The Mines of Colombia. Notes on a recent report of Mr. Stronge, the British Minister at Bogata, on the mines and minerals. 1600 w. Engr, Lond—July 23, 1909. No. 6858 A.

Exposition.

Alaskan Mineral Exhibit at A-Y-P Exposition. E. Jacobs. Shows the wealth of Alaska, and gives outline of the history of mining there. Ills. 2500 w. Eng & Min Jour—Aug. 28, 1909. No. 7390.

The Alaska-Yukon-Pacific Exposition. E. Jacobs. An illustrated article describing the mineral exhibits of the United States, Alaska and Canada. 2500 w. Eng & Min Jour—Aug. 21, 1909. No. 7183.

The Mineral Exhibit at the Alaska-Yukon-Pacific Exposition. E. Jacobs. Deals principally with the exhibits of Canada. 4000 w. Can Min Jour—Aug. 15, 1909. No. 7160.

Fissures.

The Laws of Fissures. Blamey Stevens. Presents a theory of the formation of fissures, and data supporting it. 4000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7126 F.

German East Africa.

The Ore Deposits of German East Africa (Die Nutzbaren Lagerstätten Deutsch-Ostafrikas). G. Gagel. A brief description of the deposits of economic value. 2700 w. Glückauf—July 17, 1909. No. 7273 D.

Mexican Law.

The Proposed New Mining Law of Mexico. Richard E. Chism. Discusses the provisions of a new law which is to govern mining titles and mines. 4000 w. Eng & Min Jour—July 31, 1900. No. 6792.

Mineralogy.

Simple Mineral Tests and How to Make Them. Gordon Surr. Describes a few simple tests that can be made by prospectors. 2500 w. Min Wld—Aug. 14, 1909. No. 7079.

Newfoundland.

Mineral Resources of Newfoundland. Map and General review with article by James P. Howley on the "Coal Areas of Newfoundland." Ills. 5000 w. Can Min Jour—Aug. 1, 1909. No. 6877.

Ore Deposits.

The Depth and Continuity of Fissure Veins. Arthur Lakes. Describes characteristics of different veins examined and phases of their history. 2500 w. Min Wld—Aug. 14, 1909. No. 7078.

Transportation.

The Influence of the Railroads of the United States and Canada on the Mineral Industry. James Douglas. Reviews the history of the Oregon boundary dispute and early railway projects, the routes of the railways, the distribution of mineral traffic, and related information. 21000 w. Inst of Min & Met, Bul 58—July 8, 1909. No. 7023 N.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Automatic Railroad Protection. Snowden B. Redfield. Illustrates and describes mechanical and electrical devices for the control of switches and signals. 4500 w. Am Mach—Vol. 32, No. 32. No. 7009.

Automatic Signals Near Washington, Baltimore & Ohio Railroad. Illustrates and describes this section, where the lighting of the signals is done automatically. 1600 w. Eng Rec—Aug. 7, 1909. No. 6954.

Signal Tower for Saxby & Farmer Machines. F. D. Chase. Plans and description of an interlocking tower. 600 w. Sig Engr—Aug., 1909. No. 7065.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

H 6 Equalizing Discharge Valve. Explains the construction and operation of these brake valves. Ills. 3500 w. Ry & Loc Engng—Aug., 1909. No. 6871 C.

Derrick Cars.

See Erection, under CIVIL ENGINEERING, BRIDGES.

Electrification.

The Substitution of Electric Power for Steam on American Railroads. F. Darlington. A discussion with reference to American practice, concluding that self-preservation demands its progressive

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adoption. 5500 w. Engineering Magazine—Sept., 1909. No. 7415 B.

The Electrification of the South London Line of the London, Brighton & South Coast Railway. Brief illustrated account of work in progress in England, and the equipment adopted. 1500 w. R R Age Gaz—Aug. 6, 1909. No. 6924.

Locomotive Ashpans.

The Locomotive Ashpan Situation. Editorial on the ashpans used on American locomotives, describing the self-dumping types. 1500 w. R R Age Gaz—Aug. 27, 1909. No. 7397.

Locomotive Dynamometers.

Ashton Locomotive Recording Dynamometer. Illustrated detailed description of an invention of S. T. Parks, explaining its value. 1500 w. R R Age Gaz—Aug. 27, 1909. No. 7398.

Locomotive Explosions.

The Locomotive Explosion at Cardiff Docks. Gives the Board of Trade investigation into the cause of this disaster. Ills. 5500 w. Mech Engr—Aug. 13, 1909. No. 7322 A.

Locomotive Fuel.

Coal Briquettes for Locomotive Fuel. Review of a paper by C. T. Malcolmson, read at a meeting of the Int. Ry. Fuel Assn., giving the history of coal briquetting and information related. 2500 w. Eng News—Aug. 5, 1909. No. 6912.

Locomotive Repairs.

Locomotive Repair Shop Practice. Ethan Viall. Illustrates and describes methods used at the C., M. & St. P. R. R. shops at Milwaukee. 2000 w. Mach, N Y—Aug., 1909. Serial, 1st part. No. 6804 C.

Locomotives.

Locomotives Designed and Built at Horwich, with Some Results. George Hughes. Illustrated discussion of designs and performance of locomotives. 12000 w. Inst. of Mech Engrs—July, 1909. No. 6970 N.

Simple 4-4-0 for the Idaho Northern. Illustrated description of an engine equipped with a smoke-box superheater. 500 w. Ry & Loc Engng—Aug., 1909. No. 6870 C.

Eight-Wheel Switching Locomotives for the Virginian Ry. Illustration and description of heavy engines for switching in the yards. 1200 w. Ry & Engng Rev—Aug. 21, 1909. No. 7334.

Heavy 8-Wheel Switching Locomotive, D., L. & W. R. R. Illustrated description and dimensions of an engine for use in the Buffalo yards. 1200 w. Ry & Engng Rev—July 31, 1909. No. 6818.

Eight-Wheel Switching Locomotive. Illustration and dimensions of a very compact engine for the Western Railway of Havana. 500 w. Am Engr & R R Jour—Aug., 1909. No. 6802 C.

A Swiss Mountain Engine. Illustrations and brief notes concerning an ingenious engine used on the rack railway over the Brunig Pass. 250 w. Sci Am Sup—Aug. 7, 1909. No. 6961.

Ten-Wheel Locomotive for the Midi Railway of France. Abstract translation of an illustrated description by M. Bachellery, in the *Rev. Gen. de Chemin de Fur.* 1200 w. Ry & Engng Rev—Aug. 7, 1909. No. 6955.

Ten-Wheel Coupled Superheater Locomotives of the Midi Railway (Machines à Vapeur surchauffée à dix Roues accouplées de la Compagnie des Chemins de Fer du Midi). M. Bachellery. Illustrated description and report of tests. 4500 w Rev Gen d Chemins de Fer—July, 1909. No. 7217 G.

Fireless Locomotives (Feuerlose Lokomotiven). L. Kempf. Describes and gives operating results of a German fireless switching locomotive. Ills. 3500 w. Glasers Ann—July 1, 1909. No. 7299 D.

Locomotive Stokers.

Crawford's Mechanical Stoker for Locomotives. Illustrates and describes a design of an under-feed stoker and grate. 1200 w. Mech Engr—Aug. 6, 1909. No. 7093 A.

Motor Cars.

Comparative Tests of Motor Cars and Light Locomotives (Prove di Confronto fra Automotrici e Locomotive leggere). Reports trials made on Austrian railways. Ills. 2700 w. Ing Ferro—July 16, 1900. No. 7249 D.

One-Hundred Horse-Power Steam Motor Car of the Hannover Machine Company (100 pferdiger Dampftriebwagen der Hannoverschen Maschinenbau-A.-G. vormals George Egestorff). B. Buchholz. Illustrated description of car and machinery. 2000 w. Zeitschr d Ver Deutscher Ing—July 10, 1909. No. 7470 D.

See also Motors, under MECHANICAL ENGINEERING, AUTOMOBILES.

Refrigerating.

Improvements in Refrigerator Cars. Joseph H. Hart. An explanation of the more important improvements recently introduced to increase the efficiency in the transportation of perishable products. 2500 w. R R Age Gaz—Aug. 6, 1909. No. 6920.

Shops.

New Shops of the St. Louis & San Francisco R. R. Illustrated detailed description of shops at Springfield, Mo., recently completed. 6500 w. Ry & Engng Rev—Aug. 28, 1909. No. 7402.

The Norris Locomotive Works. C. H. Caruthers. Historical review of one of the earliest plants for locomotive building. with illustrations of engines, and information relating to their performance. 5500 w. R R Age Gaz—Aug. 6, 1909. Serial, 1st part. No. 6919.

Train Resistance.

Train Resistance. F. J. Cole. A comparison of the views of different theorists, with notes from actual practice on Amer-

ican roads. 3500 w. R. R. Age Gaz—Aug. 27, 1909. Serial, 1st part. No. 7399.

Effect of Physical Characteristics Upon Train Operation. John D. Isaacs and E. E. Adams. From Bul. of Am. Ry. Engng. & Main. of Way Assn. Work for computing the behavior of any train on any grade. 3000 w. Eng Rec—July 31, 1909. No. 6798.

Wheels.

A New Process of Making Chilled Car Wheels. Thomas D. West. Discusses defects of present chilled wheels and their cause, and gives information in regard to a recent process whereby wheels with an even depth of chill are obtained. Ills. 1500 w. Ir Age—Aug. 5, 1909. No. 6891.

PERMANENT WAY AND BUILDINGS.

Cable Railways.

The Steepest Passenger Cable Railway in Europe. E. Ommeganck. Illustration and brief account of the Virgl railway, in the Tyrol, a part of which has a 70% grade. 600 w. R R Age Gaz—Aug. 6, 1909. No. 6922.

Car Dumping.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Crossing Gates.

An Automatic Crossing Gate. Illustrated description of a gate near Montreux, Switzerland. 500 w. R R Age Gaz—Aug. 20, 1909. No. 7170.

Elevated Railways.

Chicago Track Elevation of Burlington Railroad. Describes improvements involving the expenditure of $3,500,000, and amounting to a total of 51.34 miles of single track and 35 street subways. Ills. 3500 w. Eng Rec—Aug. 21, 1909. No. 7304.

New Chicago Approaches, Chicago and Northwestern Ry. Illustrates and describes the two four-track elevated approaches to the terminal of this railway. 3000 w. Eng Rec—Aug. 28, 1909. Serial, 1st part. No. 7386.

The Trenton Avenue Elevated Railroad, Philadelphia. Illustrated description of a plate-girder viaduct carrying the tracks of a branch of the Pennsylvania R. R. 2500 w. Eng Rec—Aug. 7, 1909. No. 6950.

Fire Protection.

The Relation of Railway Fire-Protection Methods and Oil-Burning Locomotives to Forest Fires. Reports the results and conclusions of the Public Service Commission's investigations. 1800 w. Eng News—Aug. 19, 1909. No. 7144.

Rails.

The Use of Titanium Rail on the Baltimore and Ohio Railroad. A. W. Thompson. States the advantages claimed for this alloy and gives results of tests and related information. 2500 w. Can Engr—Aug. 27, 1909. No. 7408.

Further Investigations of Broken Rails. Henry Fay and Rufus W. G. Wint. Read at meeting of Am. Soc. for Test. Mat. An illustrated discussion of types of fracture, their causes and suggestions for improving the quality. 2500 w. R R Age Gaz—Aug. 6, 1909. No. 6923.

Surveying.

See same title, under CIVIL ENGINEERING, MEASUREMENT.

Terminals.

Map of Chicago Terminal District. Map and index showing all the yards in the switching district and the connections. R R Age Gaz—Aug. 20, 1909. No. 7168.

Ties.

See same title, under STREET AND ELECTRIC RAILWAYS.

Track Construction.

A Special Type of Track Construction for Tunnels and Subways. Illustrates and describes the Bush system as built in the Bergen Hill tunnel of the D., L. & W. Ry. 2200 w. Eng News—Aug. 19, 1909. No. 7139.

Yard Accidents.

Yard Damage Preventives. Charles Burlingame. Suggests remedies found to give good results in lessening terminal yard accidents. 7500 w. Pro St. Louis Ry Club—July 9, 1909. No. 7017.

Yards.

The Renens Classification Yard (Etude sur la Gare de Triage de Renens). T. Balmer. Describes the yard and the method of distributing and making up trains. Ills. 4000 w. Bul Tech d l Suisse Romande—July 10, 1909. No. 7223 D.

TRAFFIC.

Demurrage.

The Private Freight Car and Demurrage. A discussion of the relation of the private car problem to the demurrage question. 3000 w. R R Age Gaz—Aug. 27, 1909. No. 7401.

Formulae.

A Method of Studying Traffic Formulae for the Exploitation of Railways of Local Interest (Note sur un Procédé d'Etude des Formules d'Exploitation pour les Chemins de Fer d'Intérêt local). M. Tourtay. Mathematical discussion. Ills. 2500 w. Ann d Ponts et Chaussées—1909-III. No. 7214 E + F.

Freight Rates.

Railway Freight Rate Making. Samuel O. Dunn. A lecture at the Univ. of Illinois. Discusses the factors that determine rates and conditions affecting them. 6000 w. R R Age Gaz—Aug. 6, 1909. No. 6918.

Construction of Freight Rates in the South. J. M. Culp. Lecture at Harvard Univ. Discusses the factors that influenced rate evolution in the south. 3800 w. Ry & Engng Rev—Aug. 7, 1909. No. 6956.

Tariffs.

Railway Tariffs, Their Compilation, Filing and Inspection. Discusses critically the filing devices and filing systems in use, especially the system in use on the Harriman lines, and the Cook system. 5500 w. R R Age Gaz—Aug. 27, 1909. No. 7400.

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STREET AND ELECTRIC RAILWAYS.

Car Bearing Friction.

Bearing Friction and Power Consumption. M. V. Ayres. A study of the saving that may be accomplished by reducing bearing friction. 2000 w. Elec Ry Jour—Aug. 21, 1909. No. 7162

Cars.

Steel Cars for Chicago Railways Company. Illustrated detailed description of all-steel surface cars of the pay-as-you-enter type. 1500 w. Elec Ry Jour—Aug. 28, 1909. No. 7371.

Electric Traction.

Rapid Transit in the Future. Trans. from *Reclams Universum*. Illustrated description of August Scherl's plan. 800 w. Sci Am Sup—Aug. 7, 1909. No. 6962.

Locomotives.

Detroit River Tunnel Locomotives. Illustrates and describes locomotives to be operated by direct current for hauling both freight and passenger trains. 2200 w. R R Age Gaz—Aug. 20, 1909. No. 7169.

New Electric Locomotives for the Simplon Tunnel (Les Nouvelles Locomotives électriques du Tunnel du Simplon). Illustrated description. Plate. 3000 w. Génie Civil—July 10, 1909. No. 7229 D.

Rack Railways.

The Montreux-Glion Rack Railway (Die elektrische Zahnradbahn Montreaux-Glion). R. Zehnder-Spoerry. Illustrated description of the line, rolling stock, etc. Serial, 1st part. 3000 w. Schweiz Bau—July 10, 1909. No. 7282 B.

kio de Janeiro.

The Transmission and Distribution Systems of the Rio de Janeiro Tramway. Light and Power Company. L. L. Perry. Editorial. Illustrates and describes a 51-mile transmission system, receiving three-phase, 50-cycle current at 88000 volts. 2000 w. Elec Wld—Aug. 12, 1909. No. 7011.

Signalling.

Automatic Signals for Direct and Alternating Current Railroads. W. B. Kouwenhoven. Explains the single-rail and double-rail systems. 2000 w. Ry & Loc Engng—Aug., 1909. No. 6872 C.

Cab Signals and Cab Telephones on the Toronto and York Radial Railway. Illustrated description of the signalling apparatus installed on an electric line running from Toronto to Port Credit. 1200 w. R R Age Gaz—Aug. 6, 1909. No. 6925.

Double-Service Electric Railway Signals. W. K. Waldron. An explanation in detail of their installation. 1500 w. Elec Wld—Aug. 19, 1909. No. 7174.

Stray Currents.

Leakage Currents. A discussion of their causes and effects. 1200 w. Elec Rev, Lond—Aug. 13, 1909. No. 7310 A.

Subways.

A Supplementary Report on the Proposed Subway System for Street Cars and Elevated Railway Trains in Chicago. Also editorial note. 2500 w. Eng News—Aug. 19 1909. No. 7142.

The Metropolitan District and Allied Tube Railways. Illustrated account of the methods and working of the Metropolitan District Railway and three underground electric lines in London. 6000 w. Tram & Rv Wld—Aug. 5, 1909. No. 7131 B.

Subway Signalling.

Time Speed Control Signals. George S. Hodgins. Describes the plan for governing approach trains to the 96th st: station of the N. Y. subway, which is a combination of the automatic stop and the time-lock principle. Ills. 3000 w. Ry & Loc Engng—Aug., 1909. No. 6869 C.

Switzerland.

Standards and Principles for the Electric Operation of Swiss Railways (Norme e Principii per l'Esercizio a Trazione Elettrica delle Ferrovie Sviggere). Emilio Gerli. A review of the report of the Swiss commission. Serial, 1st part. 3500 w. Ing Ferro—July 1, 1909. No. 7246 D.

The Economy of the Swiss Mountain Railroad (Die Wirtschaftlichkeit der schweizerischen Bergbahnen). Wolfang Adolf Müller. Statistics of cost of construction and operation, etc., of electric, rack, and cable railways. Ills. Serial, 1st part. 2800 w. Elek Kraft u Bahnen—July 14, 1909. No. 7461 D.

The Seebach-Weltingen Railway (Seebach-Wettingen). W. Kummer. Technical and economic results of tests of electric traction on this line. Serial, 1st part. 1700 w. Schweiz Bau—July 24, 1909. No. 7283 B.

Ties.

A Reinforced-Concrete Tie for Street Railways (Eine Eisenbetonschwelle für Strassenbahnen). Herr Bloss. Describes a new design, their manufacture and results of tests. Ills. 2000 w. Beton u Eisen—July 2, 1909. No. 7458 D.

Traffic Problems.

City Railways (Städtebahnen). Herr Blum. A discussion of their traffic and transportation problems. 5500 w. Glasers Ann—July 1, 1909. No. 7298 D.

Trolleys.

Derailment of Trolleys in Rounding Curves (Remarques sur les Cas de Déraillement des Perches de Trolley en Système Désaxé). G. Duez. Mathematical discussion of the forces tending to cause derailment of the trolley. Ills. 1200 w. Bul Soc Int des Elecns—July, 1909. No. 7206 F.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbè & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Bridge Design.

Secondary Stresses in Bridge Trusses. By C. R. Grimm. Size, 9 by 6 in.; pp., 140. Ills., 60. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

The discussion is limited only to the most important secondary stresses, those which are due to rivetted joints in trusses. After a general consideration of the nature of the problem and means for its solution, the five principal methods of calculation of secondary stresses, those of Manderla, Müller-Breslau, Ritter, and Mohr, and the method of least work, are illustrated. Other causes of secondary stresses than rivetted joints in main trusses are noted briefly and a chapter is devoted to a discussion of impact. The principles and methods to which reference is made are illustrated by thirteen numerical examples. A bibliography of the literature of secondary stresses and of impact concludes the volume.

Efficiency.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. Size, 7½ by 5 in.; pp., 171. Ills., 4. Price, $2, 9/-. New York and London: THE ENGINEERING MAGAZINE.

This volume is based upon a series of articles published in THE ENGINEERING MAGAZINE July, 1908, to March, 1909; but as here presented the work has been thoroughly revised, in great part rewritten, and much amplified. It constitutes the fullest and most complete statement yet made of the philosophy and practice of the individual-effort system as applied to organization, operation, and management of industrial enterprises. Its scope is generally indicated by the chapter headings: I. Typical Inefficiencies and Their Significance; II. National Efficiencies; Their Tendencies and Influence; III. The Strength and Weakness of Existing Systems of Organization; IV. Line and Staff Organization in Industrial Concerns; V. Standards; Their Relations to Organization and to Results; VI. The Realization of Standards in Practice; VII. The Modern Theory of Cost Accounting; VIII. The Location and Elimination of Wastes; IX. The Efficiency System in Operation; X. Standard Times and Bonus; XI. What the Efficiency System May Accomplish; XII. The Gospel of Efficiency.

The methods advocated have been most successfully applied in some of the largest manufacturing and operating institutions in the United States, and the author's peculiarly graphic and effective style of presenting them ranks his book among the classics of the literature of industrial engineering.

Gas Engines.

The Gas Engine: A Treatise on the Internal-Combustion Engine Using Gas, Gasoline, Kerosene, Alcohol, or other Hydrocarbon as Source of Energy. By Frederick Remsen Hutton. Size, 9 by 6 in.; pp., xx, 562. Ills., 241. Price, $5, 21/. New York: John Wiley & Sons; London: Chapman & Hall.

A third and revised edition. In the preparation of the first and second editions most prominence was given to the principles and functioning of the internal-combustion engine. The last edition has been amplified to cover more of the quantitative requirements of the engineer and builder.

Heating.

Practical Steam and Hot Water Heating and Ventilation. By Alfred G. King. Size, 9 by 6 in.; pp., 402. Ills. Price, $3. New York: The Norman W. Henley Publishing Company.

A book designed for the use of heating contractors, steam fitters, steam fitters' apprentices, architects and builders. All technical matter beyond the comprehension of the man of average education has been eliminated; by means of illustrations and simple rules and explana-

tions, the author aims to make plain to the steam fitter or apprentice the best methods of estimating and installing work by any one of the modern methods of heating and ventilation now in use. All the principal systems of steam, hot water, vacuum and vapor-vacuum heating, the new accelerated systems of hot water circulation, and the fan system of heating and ventilation are described in simple language. A chapter is included on estimating for heating contracts, specifications for steam and hot water heating, and general business methods.

Irrigation Engineering.

Irrigation Engineering. By Herbert M. Wilson. Size, 9 by 6 in.; pp. xxix, 625. Plates, 38. Ills., 195. Price, $4, 17/. New York: John Wiley & Sons; London: Chapman & Hall.

Since it was first published in 1893, this work has run through five editions. A sixth is now presented, embodying the important changes which have taken place within recent years in the design of structures on irrigation works and the materials used in their execution, due principally to the activity of the United States Reclamation Service. For this edition the book has been almost entirely rewritten, a large amount of obsolete matter eliminated and much new material inserted. It is now a thoroughly dependable summary of the prevailing practice in irrigation engineering in the United States. Chapter headings include: Introduction; Precipitation, Runoff and Stream Flow; Evaporation, Absorption and Seepage; Alkali, Drainage and Sedimentation; Quantity of Water Required; Flow and Measurement of Water in Open Channels; Subsurface Water Sources and Sewage for Irrigation; Classes of Irrigation Works; Alignment, Slope and Cross-Section; Headworks and Diversion Weirs; Sluiceways, Regulators, and Escapes; Falls and Drainage Works; Distributaries; Application of Water and Pipe Irrigation; Location and Capacity of Reservoirs; Earth and Loose-Rock Dams; Masonry Dams; Wasteways and Outlet Sluices; Pumping, Tools and Maintenance; and Reclamation Service of the United States.

Marine Engineering.

Handbook for the Care and Operation of Naval Machinery. By Lieut. H. C. Dinger, U. S. N. Size, 6½ by 5 in.; pp., 302. Ills. Price, $2. New York: D. Van Nostrand.

The larger part of the contents of this book appeared originally as a series of articles in the *Journal of the American Society of Naval Engineers*. With some revisions and numerous additions this material is offered as a concise and simple description of the care and operation of naval machinery on points not largely touched upon in the standard treatises on marine engineering. The three chapters in Part I deal, respectively, with getting underway, running engines underway, and accidents underway. In Part II seven chapters are devoted to the care and overhaul of main plant. Chapters XI to XXIII, which constitute Part III, discuss the care, maintenance and repair of fittings and auxiliaries. Part IV has two chapters on the care, preservation and sub-division of the hull, and Parts V and VI, with five and two chapters, respectively, deal with special auxiliary engines, such as steam-steering gear, air compressors, etc., and spare parts and tests.

Marine Engineering. By Engineer-Commander A. E. Tompkins, R. N. Size, 9 by 6 in.; pp., 812. Ills. Price, $4.50. New York: The Macmillan Company; London: Macmillan & Co.

A third edition of a work which appeared first in 1896. For this edition the whole of the book has been rewritten and revised and a large number of new illustrations have been added. It is now offered as a complete and thoroughly up-to-date text-book on marine engines and boilers, and a summary of the best practice of the present day. The thirty-five chapters are grouped into ten sections, of which the headings are: Introduction; Marine Boilers; Combustion; The Marine Reciprocating Engine; The Condenser, Steam, and Feed-Water Systems; Steam, The Working Substance; Propulsion; Auxiliary Machinery; Care and Management; and Recent Developments. In the section on recent developments, two long chapters are devoted to the marine steam turbine and the internal-combustion engine. The illustrations are numerous and, in general, well chosen, and the work is, on the whole, a satisfactory, though by no means exhaustive, presentation of the subject.

Mine Accounting.

Simple Mine Accounting. By David Wallace. Size, 9 by 6 in.; pp., 63. Ills. Price, $1. New York and London: Hill Publishing Company.

A useful little book intended primarily for those who have had no time to include among their other studies that of bookkeeping. The explanations and illustrations have been simplified as much as possible for the guidance of superintendents,

mine foremen, timekeepers, and others with no knowledge of accountacy who have charge of the accounts of mining operations. The development of a bookkeeping system from the commencement of operations is described, and forms are shown illustrating the accounts necessary as the business increases. The subjects include cash book, vouchers and drafts, pay rolls, hospital fund, material account, distribution of accounts, journal and distributing record, ledger, and profit and loss account.

Street Cleaning.

Modern Methods of Street Cleaning. By George A. Soper. Size, 9 by 6 in.; pp., 201. Ills. Price, $3. New York: The Engineering News Publishing Company.

As the first work in English devoted to the principles and practice of street cleaning, Dr. Soper's admirable little book supplies a serious lack in the literature of municipal sanitation. The material is based partly on the author's extensive experience in American cities, but more particularly on studies made in Europe in 1907, when he acted in an advisory capacity for a commission appointed to investigate the street-cleaning problems presented in New York. An introductory chapter discusses the use and abuse of city streets and outlines the main sources of street dirt. The fundamental principles applicable to street cleaning are then taken up, as an introduction to a discussion of the various methods of cleaning pavements. Chapter IV deals with the disposal of refuse by dumping on land and at sea, by incineration, and for fertilizer. A summary of European methods of street cleaning precedes chapters devoted to detailed studies of practice in London, Westminster, Manchester, Paris, Berlin, Hamburg, Cologne, Amsterdam, and New York. Many cost data are given, and the whole treatment of the subject is thoroughly practical. A number of excellent illustrations add greatly to the interest of the text.

BOOKS RECEIVED.

The Architect's Directory and Specification Index, 1909. Size, 10 by 7 in.; pp., 212. Price, $3. New York: William T. Comstock.

How to Use Slide Rules. By D. Petri-Palmedo. Size, 7 by 4 in.; pp., 66. Ills. Price, 50 cents. New York: Kolesch & Company.

Physikalische Chemie der Metalle. By Rudolf Schenck. Size, 10½ by 7 in.; pp., 193. Ills., 114. Price, M. 7. Halle a. S.: Wilhelm Knapp.

Erecting Work. By Hubert E. Collins. Size, 7 by 5 in.; pp., 140. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Knocks and Kinks. By Hubert E. Collins. Size, 7 by 5 in.; pp., 137. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Pipes and Piping. By Hubert E. Collins. Size, 7 by 5 in.; pp., 140. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Berechnung und Untersuchung des Eisenhochofens. By Carl Brisker. Size, 10½ by 7 in.; pp., 101. Ills., 37. Price, M. 4.50. Halle a. S.: Wilhelm Knapp.

Construction des Machines et Appareils électriques. Size, 10 by 6½ in.; pp., 344. Ills. Price, 3 fr. 50 c. Brussels: Office du Travail et Inspection de l'Industrie.

Systems of Governing and Valve-Gears of European Gas Engines. By R. E. Mathot. Size, 9½ by 6 in.; pp., 58. Ills. Price, 3s. Brussels: Published by the Author.

Reinforced Concrete: a Manual of Practice. By Ernest McCullough. Size 8 by 5 in.; pp., 128. Ills. Price, $1. Chicago: Cement Era Publishing Company.

Differential and Integral Calculus. By Daniel A. Murray. Size, 8½ by 5½ in.; pp., xviii, 491. Ills. Price, $2. New York and London: Longmans, Green & Co.

Versuche mit Säulen aus Eisenbeton und mit einbetonierten Eisensäulen. By Fritz v. Emperger. Size, 10½ by 7½ in.; pp., 57. Ills. Plates, 7. Price, M. 5. Berlin: Wilhelm Ernst & Sohn.

Die rationelle Auswertung der Kohlen als Grundlage für die Entwicklung der nationalen Industrie. By Franz Erich Junge. Size, 9½ by 6½ in.; pp., 91. Price, M. 3. Berlin: Julius Springer.

A Brief Course in Elementary Dynamics for Students of Engineering. By Ervin S. Ferry. Size, 9 by 6 in.; pp., 178. Ills. Price, $1.25. New York: The Macmillan Company; London: Macmillan & Co.

Hüttenwesen. Kurze Uebersicht über die heutigen Verfahren zur Gewinnung der wichtigeren Metalle. By Dr. W. Borchers. Size, 11 by 7½ in.; pp., 192. Ills., 218. Price, M. 8.75. Halle a. S.: Wilhelm Knapp.

The Elements of Physics. By Edward L. Nichols and William S. Franklin. Volume II, Electricity and Magnetism. Second edition. Size, 8½ by 5½ in.; pp., 303. Ills. Price, $1.60. New York: The Macmillan Company; London: Macmillan & Co.